Devoted to Civil Engineering and Contracting

May 31, 1928

Engineering News-Record

Water Works and Supply

Operating Problems of Spring Valley System

Trunk-Main Water-Distribution System for Greater Detroit

Colorado River-Los Angeles Aqueduct Project

Experimental Water-Filtration Plant at Chicago

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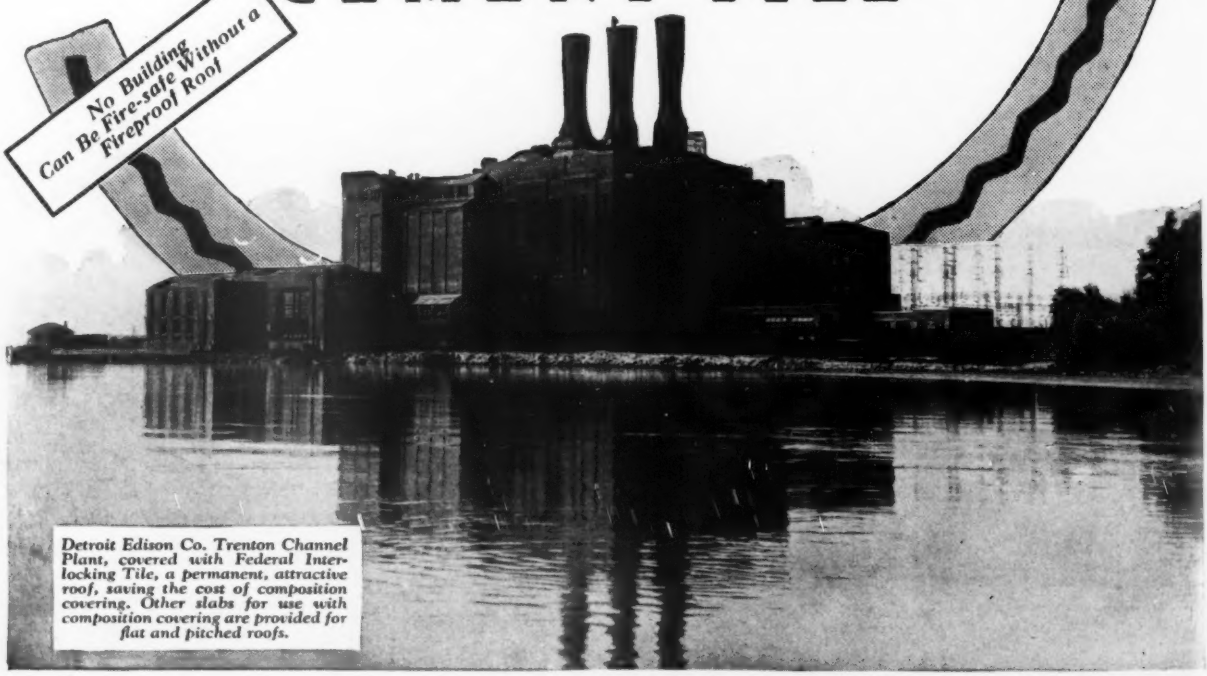

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At the Golden Gate

FOR the first time in its history the American Water Works Association meets farther west than Denver. Aside from two conventions in that city it has never gone beyond the Missouri, and so the present occasion constitutes belated recognition of the importance of the far West. In development of water-supply problems quite as much as in city growth and in evolution of self-government the regions beyond the Divide have done many things that may serve as models to the East. Moreover, Western water-works men have stood loyally with the national association and have labored faithfully in its behalf. In acknowledging the force of these motives by its choice of meeting place, the Association has taken an important step in its own interest. It is helping itself to become more nationally minded, and through this it will gain in breadth, in ambition and in ideals. These are vital factors in society life, and most needed by an organization that is consciously working up toward higher levels. "Westward" has ever been synonymous with progress.

Work Ahead

IF THE water-works men at San Francisco are to reap full benefit from the meeting, they must resign themselves to hard work. A program of no less than 63 papers confronts them—evidence of more kindness than firmness on the part of the program committee. Many sessions are provided for, but even with parallel sessions the program is heavily overloaded in places. It would seem that discussion is all but impossible under these conditions. Yet, since discussion is the very life of a technical meeting, the officials of the Association face the definite duty of conducting the sessions so efficiently and systematically that discussion may be freely and fully developed, without depriving any author of the opportunity to lay the essential message of his paper before his hearers. Were we to look back some years to earlier meetings of the Association—say fifteen years ago—we should think this an impossible demand. It is quite possible today, and if it should call for strenuous executive control of the meetings it will, we believe, justify itself by the results.

Fostering the Crafts

AS THE world grows, ever greater importance is assigned to organization, to great size of co-operating units and to the intricate mechanism of co-operation But after all the vitality of organized work will continue to rest on the excellence of individual effort. Engineering and building, for example, can never be stronger and sounder than the craftsmanship of the individual artisan, the working unit in their ranks. Some years ago this truth was perceived by a few thoughtful engineers, and some influential groups of building interests undertook to apply it by awarding special distinction to craftsmen who had made excellent performance in the construction of a large building. The award of these certificates of merit, originating within the New York Building Congress and soon taken up by similar bodies elsewhere, is leading to results. Craftsman, builder and architect alike have been drawn into keenly interested participation. Slowly but surely the pride of craft, finding its recognition, is being reawakened to new life after years in which this vital incentive seemed to be ebbing away. The effort of the single worker's skill and devotion is now finding the recognition which modern superorganization tends to take from him, and the influence of such recognition is unquestionably far reaching. It is a pleasure to record the fact that the craftsmanship movement thus is producing results in keeping with the fine spirit which conceived it.

A Bad Sequence

DAM failures or near-failures are becoming uncomfortably frequent. South Carolina having just experienced a panic over the threatened failure of an earth dam, Utah comes along to mach the record with an incipient washout of a combined earth and rock-fill dam. In this new instance, settlement cracks which formed in the earth portion of the fill gave the water opportunity to cut through the bank, preliminary reports indicate. That the whole dam did not go appears providential, as in the Greenville case. Both accidents focus attention on certain easily overlooked hazards of dams, and to this extent have a useful effect. But this effect is insignificant compared with the undermining of general confidence in dams. The quick succession of St. Francis, Greenville and Pleasant Valley tends strongly to brand dams as dangerous structures in the estimation of the public. As a result, the art of dam construction is in an exceedingly grave situation, one which suggests at once that a scrutiny of general practice in the field of dams is in order. If safety margins have been trimmed too close, so close as to leave insufficient reserve against the many unforeseeable contingencies that dams are heir to, it is time to take a new attitude. Dams must be the safest structures that human skill can construct.

A Fallacy Exposed

FOR some years it has been currently believed that mining is one of the unlucky, profitless branches of industry. Everybody thought that it had never recovered from the miscellaneous succession of hard blows it received just after the war-time boom and that probably it would never recover. All this is contrary to fact, we now learn. A study of the financial results of mining enterprises for 1926 and 1927, carried out by A. B. Parsons, of the *Engineering and Mining Journal*, and published in the current issue of the *Journal*, shows that mining as a whole was well up toward the middle of the scale of profitableness in the entire list of major produc-

ing industries of the country—farming, of course, excepted. Lead and zinc mining indeed was second in the list of industries according to profit-ratio, being exceeded in 1927 only by the automotive industry; and in 1926 the lead-zinc group was at the top of the list! Gold and silver mining held third rank in the list during both years, standing more than 10 per cent better than electrical manufacturing and the production of chemicals. Of course, these two branches of mining are characterized by short life, so that a heavy depletion charge ought to be deducted from the tabulated profits. But that this factor is not controlling appears from the fact that the mining industry in its entirety, as well as the smelting industry, showed a much higher profit-ratio than such a standard enterprise as steel and iron production. No longer need we waste sympathy on mining investors and operators, for they are evidently quite well off. It is specially interesting, however, to note one factor in the situation—namely, the reduction of production costs per unit within the space of a single year. Mr. Parsons reports that over-all production costs of copper were cut one-half cent per pound, or 5½ per cent, in 1927 as compared with 1926, and those of lead and zinc by nearly three-quarters cent per pound, or almost 25 per cent. These figures clearly reflect a steady increase in efficiency of mine and smelter operations. Even our most rapidly evolving industry, automobile production, could hardly show a more gratifying improvement in efficiency during a single year. The figures represent not only a gain for the year just past but a gain that will stay with us permanently; it means a lasting increase of the country's consuming power.

Maximum Rainfall and Runoff

NATURE is continually outdoing herself, or rather outdoing the records set down by man during the few years since he began to make reliable observations. A fresh illustration is afforded by recently reported flood flow records of California mountain streams noted two weeks ago. The runoff was double that of any previously recorded. True, the period of reliable records is only some 25 years, but for many streams of the United States and Canada dependable records of even that length are lacking. Undue stress should not be laid on the fact that a long-continued high rainfall was augmented by melting snow, this secondary contribution being increased by relatively high temperature. In the Sierras such a coincidence may occur any spring. Nor is there any certainty that the excessive runoff of last March may not be exceeded, for although the weather was warm during a considerable part of the storm, it became sufficiently cooler at the end that the rain turned into snow and the old snow blanket stopped melting. Next year the warm weather may continue throughout the storm, thus establishing another record breaker. A little later the rain might extend for a longer time, or if it stopped, the warm weather and melting snow might continue and still another maximum be set up. If instead of 25 years of reliable record there were 100 years, the maximum might be exceeded in the 101st year. Perhaps the same would be true if the record covered 1,000 years. Speculation on these points is of no practical use. The fact is that for nearly every river drainage area of the country there are no reliable records of rainfall and runoff exceeding 50 years, while for but few do they reach 25 years. Moreover, in the best case the number of observing stations in any one drainage area is wofully inadequate, particularly west of the Mississippi River and at high altitudes the country over. Many engineers are well aware of the deficiencies, and use rainfall and runoff data with due caution, but very few exert themselves to make good the deficiencies through efforts to obtain extensions of federal, state and city rainfall and runoff observations. Efforts in this direction constitute a service to the community.

Present-Day Water Problems

WHEN we talk of water supply today we speak in terms of billions of gallons and hundreds of millions in cost. Chicago—more wasteful than lavish—pumped well toward a million gallons of water a day last year. Even when, if ever, it gets 90 per cent of the supply metered, growth meanwhile will have brought the demand up to a billion gallons a day. New York, a larger city, will soon be supplying a like or larger average. Detroit, with plans for a vast metropolitan district in effect, will also find itself in the billion class. Across the continent Los Angeles, in planning for an entire county, proposes to add nearly a billion gallons potential to its existing large supply. And for lesser cities, if total volume is smaller, in ratio to population and wealth the future water demands and the skill and cost required to meet them are equally impressive.

Broadly, it is not because of increasing per capita demands that the water-supply problems of our cities great and small are increasing. Rather it is through sheer growth of population, larger area to be supplied—both often embracing many cities joined in a water-supply district—and higher standards of quality and reliability of supply that these immense volumes and complicated technical problems arise. Add to all this the fact that, except for cities on the Great Lakes, the Mississippi and a few other large rivers, it is becoming necessary to go farther and still farther afield for water and the magnitude of the water-supply problem of today begins to loom large. Larger still it becomes when account is taken of the fact that obtaining an ample supply of pure, clear, colorless and tasteless water is only the beginning of the water engineer's task. Distribution has its problems, notably the laying out of district supply areas and serving them through trunk mains and, except on gravity supplies, raising the water by pumps and storing it in tanks and reservoirs.

Examples of these many problems and how they are being solved are afforded by the articles on large and small water-supply, pumping, treatment and distribution systems printed in this issue. Most appealing to the imagination because of the distance to be traversed and the mountains to be overcome by tunneling and by pumping is the article on the Los Angeles-Colorado aqueduct survey. Having come near the end of the capacity of its present sources of supply, including the long aqueduct extending to the high Sierras, far to the north, the city now proposes to go 300 miles eastward to the Colorado, and to pump the water over an elevation of 1,400 ft. And this for an ultimate supply of nearly a billion gallons daily! In length and lift the Coolgardie pipe line exceeds this aqueduct, but in diameter and capacity the Australian conduit is comparatively insignificant.

At Chicago, a problem of quite another sort, common to the Great Lakes cities and too long postponed at Chicago, is to decide on the best plan for treating a water supply which, as already stated, now averages nearly a

billion gallons a day. With such a huge volume to be treated every day it can readily be seen that a saving of only a few cents a million gallons treated would run to a large yearly total; that anything materially increasing the unit rate of treatment will decrease capital charges, but that this might be largely offset by adopting a method that increased operating expenses.

Some of the problems of distribution are illustrated in the article on planning distribution areas at Detroit; as contrasted with a flat city, the article on distribution problems at Portland, Ore., may be mentioned.

Only a few of the water problems of today are mentioned in the foregoing remarks. But it is easily seen that vast outlays and a huge total of capital and operating charges are being made to meet the rapidly growing demands for water for our cities, and particularly to meet rising standards. Per unit of volume supplied the cost of water is rapidly increasing. Part of this is due to the depreciated dollar. The increase would be far greater were it not partly offset by improved equipment, which affects both construction and operating costs. In capital outlay and yearly charges the most notable decrease in cost is due to the use of pumps, which in size and material are pigmies compared with the giants of old. Most fortunately, there is a growing degree of parity between the efficiencies of the old and the new types of pumps.

However great the unit cost of water may be today, it is low compared with that of any other utility. With proper water rates, which some cities do not yet have, our public water supplies add little to the general tax rate, and properly distributed that little is after all only a charge for some other classes of service, as fire protection, or schools. There is no occasion to call a halt in water-supply extensions and service improvement.

The Public Health Bill Veto

ENGINEERS in the United States Public Health Service have again met with disappointment. For years past their friends in and out of Congress have been trying to have these men given the same status as the doctors in the service, who receive commissions and besides the standing thus given are assured of permanent commissions and liberal yearly pay on retirement. At least twice a bill putting these engineers on a par with the doctors has passed one of the houses of Congress, but failed in the other house or was lost in the session-end shuffle. During the past year the American Public Health Association, the American Society of Civil Engineers and various other national organizations, acting as a whole or through committees, backed a bill which provided for the co-ordination of the Public Health Service and would have made possible important extensions in its work. This bill passed both houses of Congress, only to be vetoed by President Coolidge.

There are some twenty-five men in the Service at present. Their best known work is the administration of the so-called Treasury regulation of the hygienic character of drinking water offered to the public on railways and steamships engaged in interstate commerce. This is done in conjunction with state health departments and with the co-operation, as a rule, of local health and waterworks officials. As nearly all the drinking water on trains and much of that on ships is taken from public water supplies, the Treasury standard and its enforcement have a far-reaching effect on the quality of the American water supplies, for even where these supplies are not taken aboard trains and ships the Treasury standard is in large measure the standard. Since nearly every one travels by rail or boat in these days, and all who do not are subject to possible typhoid infection from those who do, it is no exaggeration to say that more than a hundred million people are concerned, little as most of them realize it, with the drinking water supplied in interstate commerce and thus with the work of the engineers of the Public Health Service.

Other work of the Public Health engineers, which can be barely mentioned here, centers in the sanitary protection of city milk supplies and of shellfish, in mosquito and malaria control, and, of great importance at times, in their assignment to help control local epidemics and to sanitary and health protection work in times of such disasters as the Florida hurricane and the Mississippi River flood.

In much of their activities the engineers of the Public Health Service work alongside the doctors—or surgeons, as they are called—of the same service. Comparisons are invidious, so it will suffice to say that the health and life of millions are affected by the work of these two branches of the Public Health Service; yet the doctors are commissioned officers and the engineers lack equal standing.

President Coolidge justified his veto on constitutional grounds—infringement of the appointing power—but he expressed for himself and the Secretary of the Treasury strong opposition to the bill because it would increase the militarization of federal employees. This militarization would come solely through commissioning sanitary engineers—and also some other technically trained men—exactly as the doctors in the Public Health Service are commissioned. No recognition of the injustice of commissioning the doctors and withholding commissions from engineers, men of equal importance in the protection of the public health, is voiced in the veto.

The objections to militarization, expressed in the veto, have a broader aspect than their effects upon the engineers and other technically trained men in the Public Health Service. The chief specific argument against militarization advanced in the veto is, in substance, that there is no difficulty in keeping the ranks of civil service employees filled without granting commissions. Is it the President's main concern to keep the civil service ranks filled?

Although the chief ground given for the veto was the unconstitutionality of the bill, and sympathy with its main objects was expressed, later on the veto states that if full power over appointments were invested in the President, and the militarization feature eliminated, he would be glad to sign it. Altogether, it appears that militarization is the big bugaboo in the bill. This is a regrettable attitude from the viewpoint of equal justice to engineering and medical branches of the Public Health Service and of the broader application of the argument against militarization already mentioned—which affects many engineers and other technical men in various branches of the federal service.

Another Congress can easily remedy the alleged unconstitutional feature of the vetoed bill—which seems to rest wholly on whether the examining board and the surgeon general should merely recommend appointments and promotions, or specify, as the bill says in effect, those to be preferred. This change would seem to be reasonable, whether constitutionally imperative or not. The provision for commissioning all professional men in the service should remain, instead of permitting the continuance of unjust preference for the medical officers.

Looking Across College Hill Reservoir, San Francisco

Operation and Maintenance of Distribution System of Spring Valley Water Company

Organization of 160 Men Makes Extensions and Takes Care of Mains, Gates, Services, Meters Reservoirs, Pumps and Grounds—Company Makes Some Tools and Other Supplies in Own Shop

By George Pracy
Superintendent Distributing Department,
Spring Valley Water Company, San Franscisco, Calif.

THE operation and maintenance of the city distributing system of the Spring Valley Water Company costs about $500,000 a year; the routine construction work, another half-million. The company supplies an average of about 55 m.g.d., using for this purpose, within the city, five steam pumping stations, ten electrically driven pumps, seven reservoirs, twelve tanks, 750 miles of pipe and 105,000 services and meters.

Organization—This work is carried on by about 160 men distributed generally as follows: General supervision, 2; records and clerical, 9; service and meter, 33; main pipe, 49; machine shop, 10; pumping stations, 48; reservoirs, 5; screenhouse, 3; gardeners, 2. The crew is increased when the construction program warrants it. The largest group of men, known as the main pipe gang, takes care of all the general work in the city, including not only the laying of the main pipes and the repairing of breaks but also all of the general work around the reservoirs, pump stations and other property. Working under a general foreman, they operate in various combinations as demands require. Their principal job is laying pipe and repairing breaks in the main pipe system.

The topography of San Francisco is very uneven, the elevations running from sea level to 930 ft. The area of the city is 26,000 acres, or about 41 square miles. A tabulation of soils made during our rate case showed that 41 per cent of the city pipe is laid in sand, 21 per cent in sandy clay, 18 per cent in hard clay, 14 per cent in soft rock and 6 per cent in hard rock.

Mains—Under our climatic conditions, no protection against freezing is necessary and mains are laid with 2 ft. of cover; services with 2 ft. or less. Our mains are nearly all laid in built-up streets under paving, so that excavation is by hand. Our particular conditions do not make an excavating machine feasible.

Paving is cut by tools operated by compressed air, the compressors being of 90-cu.ft. capacity, mounted on an extended Ford truck equipped with a four-speed axle. For a while we had the machines mounted on an ordinary Ford truck, which, in our opinion, proved slightly too small for the job. As we have four compressors working, each with a complete set of hose and paving breakers, we have had some trouble with equipment due to one outfit getting mixed with that of another. There is one man in charge of each machine and as each one is anxious to have good equipment, we sometimes feel that this changing of equipment may not always be accidental. To avoid this, the hose and tools from each machine are painted a distinct color, corresponding to similar markings on the compressor. This scheme is, as yet, too new to have developed its faults.

In the sand and sandy clay, no picking is necessary, and a man will move from 8 to 10 yd. or even more in a day. In the heavier soils, the air spade is used and rock is broken out in the same manner as concrete at a saving in cost. As the paving must go back as soon as possible, proper tamping is a problem. Air tamping has been used lately as being better, though not cheaper, than hand tamping. For laying 4-in. pipe, the paving is cut 12 in. wide; for 6-in., 16; for 8-in., 18. The pipe is hauled to the job by a Fordson, 6 tons on a trailer. This is the cheapest method of hauling that we have been able to devise. Besides hauling pipe, this outfit does most of our other heavy hauling.

Joints—Cement joints have been used in laying cast-iron pipe for eleven years with entire satisfaction. This material is certainly as good as and perhaps better than lead. We have had no experience with leadite or similar substances. The various modern types of cast-iron pipe have all been used and proved sufficient.

Fittings—Our fittings are made locally from our patterns. These patterns have the same laying length as standard flanged fittings, with all other dimensions conforming to American Water Works Association standards. We cannot see sufficient hydraulic advantage in the larger fittings to offset the greatly increased price. For instance, an 8-in. A.W.W.A. cross with four bells weighs 372 lb. and has a laying length of 26 in.; ours, 289 lb. with a laying length of 18 in. Up to about three years ago we held the plugs into the bells with what we called a bell-band and cross-bar combination; a band that bolted on around the pipe in back of the bell and an iron bar in front of the plug, with two bolts taking the strain from the bar to the bell band. At that time we read of a scheme of reversing the plug, using cap screws that went through the side of the plug and fitted into the groove in the bell, taking the load off of the lead joint. We have used these plugs since then with entire satisfaction and considerable saving.

Trucks—Aside from the trailer we use only 1-ton Ford trucks. For our work we cannot see wherein a larger, more costly truck would be to our advantage. The smaller jobs are handled by crews of three or four men with a truck. Two trucks handle the small hauling to the larger jobs as well as the miscellaneous deliveries to the pumping stations, reservoirs and other parts of the plant.

Gates—The gates in the city pipe system are operated by a group of five men known as gatemen. No other man is allowed to handle them. These men work in rotative shifts, three being on the day watch, one on duty from 4 o'clock to midnight and one from midnight to 8 o'clock. They keep a record of all sections shut down, counting the number of turns on each gate, and report

METER BATTERY, SPRING VALLEY WATER COMPANY
For services of over 2-in. diameter, batteries of 2-in. meters are used.

READY TO GO; SPRING VALLEY WATERFRONT CREW

immediately when any gate does not operate properly. No routine examination of gates is made and to my knowledge no trouble has ever ensued on that account. Gate covers are frequently covered when the bitumen street surface is renewed, but such work is caught by observation. An accurate record is kept of the location of all gates and very little trouble is encountered in locating them. In the last few years the new type of residence subdivision with its curving streets and lack of defined property lines has made definite measurement much harder than with a rectangular layout. In these places measurements are taken from curbs. When possible, additional measurements are taken from permanent structures. For gateboxes, we use a piece of 6-in. pipe with a cast-iron cover. The pipe is set on two bricks with a cushion of dirt between the bricks and the gate.

The gateman kept on duty outside of working hours is the entire emergency crew. During the nineteen years that I have been in this work I do not know of a case where any damage has resulted through maintaining a one-man crew. I do not mean that we have not paid damages due to mains breaking at night, but merely that these damages would not have been any less if more men had been on watch. The night gateman stays on watch at the telephone board in the main office. When a leak is reported, the gateman leaves the board in charge of one of the janitors, all of whom are capable of handling it, and goes to the place of the leak in an automobile. Once there, with a knowledge of the trouble, he uses his best judgment in deciding what to do.

Services—The service and meter work is done by a crew of 30 men working under a general foreman. In addition, three men work in the meter repair shop. These men install and maintain all services and meters and take care of service leaks and complaints, including work due to street grading and setting back of curbs, a great deal of which is always in progress. The men work mostly in pairs, one serviceman and one laborer with a Ford truck. On some of the larger services, a serviceman may have two laborers. Meter changing and testing keeps two two-men crews busy. Meters are tested at the curb by running 10 ft. of water into a calibrated tank.

Prior to 1908 all services under 3 in. were made of lead pipe, using a driven tap. Since that time we have used galvanized pipe with a screw tap. All our threads are Briggs standard, which enables us to plug the tapped holes in mains with a standard screw plug. The minimum service is ¾ in. We have no maximum limit; the largest service now in use is 8 in. While we do not quite like the very large services, we have never had any real

reason for being afraid of them. At no time have they threatened us with trouble.

An air compressor is sent out ahead of the servicemen to cut the pavement. Most of the services are driven across the street under the pavement. A hole about 18 in. square is cut over the main. Sometimes the service can be driven all the way across, sometimes another cut about 6 ft. long must be made in the pavement. In the long drive, the pipe is driven from the sidewalk to the main. The connection between the tap and service is made with a piece of lead pipe with lead and iron unions. These lead connecting pieces of the ¾-in. size are made of B lead, each piece being 18 in. long. A galvanized-iron union is used on the pipe end with a saving in price over the brass union formerly used. On the tap end, a brass union piece that comes with the tap is still used. Leather washers are used in making the joints.

Services are put in ahead of paving when the property owner pays for the cost of the work, the average value of each service being refunded to him when it is put into use. While there may be some disadvantages to this, as a dead service must be maintained and perhaps renewed, it saves cutting and replacing the pavement.

Meters—On services up to 2 in. we use a single ordinary disk meter. Above 2 in. we use batteries of 2-in.

CENTRAL PUMP HOUSE, SPRING VALLEY WATER COMPANY

The upper inscription reads: "But the land whither ye go to possess it is a land of hills and valleys and drinketh the water of the rains of heaven." Above the entrance is inscribed: "Let thy fountains be dispersed abroad and rivers of waters in the streets."

meters: two 2-in. for a 3-in. service; four 2-in. for a 4-in. and six 2-in. for a 6-in. service. These relative capacities are based on a 5-lb. loss. We tried using a battery of two 3-in. meters instead of four 2-in. on a 6-in. service, but found it not so convenient and more costly as well. On the sprinkler services, we formerly set the detector type of meter, but after about fifteen years without any registration on them, we changed to the detector check, which registers only up to the capacity of a 1½- or 2-in. meter. All water passing through the main pipe is not registered.

All new meters are tested before being set. The gears are set to give as close to, but not over, 100 per cent registration as is possible. About 90 per cent of the meters set are of the ⅝-in. size. Only very minor repairs are made in the field.

Our meters are set at the curb so that the top of the meter is about 6 in. below the finished sidewalk. Concrete meter boxes are used in lawns. In cement sidewalks the same general cover is used except that there is no depth to the box, only the top 3 in. of the box being made. In business districts the meters are set in basements.

Reservoirs—Three men do the routine work around the reservoirs, extra work being done by the main pipe gang. Reservoir gages are read at 7 a.m. and 7 p.m., the readings being telephoned to the main office and later given to the assistant superintendent, who regulates the water supply. With one of our reservoirs, about 300 ft. in diameter and 16 ft. deep, with sloping sides, we are troubled with growing weeds which reach the surface of the water each year in the autumn. These we clean out by means of a drag, made of a piece of 2-in. steel pipe with harrow teeth fastened through it so that the teeth point backward and downward. This is taken out to the center of the reservoir in the stern of a rowboat, thrown overboard and then hauled ashore by a windlass. Each raking brings forth a goodly load, diminishing on the second round. The weeds are forked up on the bank and later hauled away. Occasional trouble with muddy water during the rainy season has been overcome by feeding alum into the supply main before it empties into the reservoir. The floc formed completely settles the mud in the reservoir, leaving absolutely clear water. This has been tried several times and has always been successful. The alum is mixed in redwood tanks, experience dictating how great a dosage to use. Our solution to the seagull problem is told elsewhere [see p. 868 of this issue].

Pumps—Our steam pumps are the ordinary crank-and-flywheel pumping engines. Our station practice is typical. Each pump is overhauled every year, with the result that, though they range from 35 to 40 years in age, they are in perfect shape. During the past three or four years we have been experimenting with pump valves in an endeavor to get a valve that will give the lowest total operating cost, considering both the cost of the valve and the life of the valve decks. Belata, rubber and leather have been tried with no positive results so far. We are now experimenting with iron valves in which are glued two rings of leather.

Eight of the ten electric pumping stations are automatically operated, either by a pressure control or by a float switch. Power is furnished by the local power company, the wires from the tanks to the pumps being strung on their poles. One man, with a runabout, keeps the plants running. We have very little trouble, the small pumps operating as nearly perfectly as is possible for that type of machinery.

Machine Shop—The machine shop, while a part of the city distributing system, actually does the machine work for the entire works. In a small but fairly well-equipped ship the foreman and nine men maintain the automobiles used within the city and do all the overhauling or repairing of the cars used outside of town. Practically all of the pump repair work is done in the shops, only an occasional large job being sent out. While the shop pays its way in these items, it also turns many small losses into profit. Old brass fittings, formerly junked, are now kept until a small barrel is full and then are sent to the shop, where they are repaired. Some, of course, are beyond redemption, but the work leaves a good profit. Broken tools, wrenches, small pumps, even paving-breaker cylinders, are restored to condition and sent out again. The welding torch, the use of which has been developed to a fine point, is a wonderful help in the reclamation of broken pieces. Combined taps and drills, formerly bought to fit the tapping machine, are now made by welding a

shank to a standard tap and drill. Pump-valve springs of all sorts are made, new bronze valve seats welded into valve decks, and gate stems turned out, as are numerous other parts needed to keep a large system in trim. All nipples are made in the shop, the short, left-over pieces of pipe being used for this purpose. Costs are kept of all things made so that we are sure that our savings are real. These costs cover all labor, material and shop overhead, but do not include general overhead nor interest charges.

The automobile repairs are managed the same as in a good commercial repair shop. The machines are mostly filled and greased at night. The few cars that are kept away overnight must be taken care of during the day. Records of tires, oil and gasoline are carefully kept and the men advised of them. Each driver keeps the same car and knows that any misuse will reflect upon him.

Additional Water Supply for Manila, P. I.

Gravity Aqueduct of 80-M.G.D. Capacity From Angat River With Filtration Plant and Emergency Storage Reservoir

By Paul W. Mack
Chief Engineer Angat Project, Metropolitan Water District, Manila, P. I.

DON FRANCISCO CARRIEDO Y PEREDO died in 1743. Among other bequests, he left 10,000 Spanish pesos to the city of Manila to be invested until interest and principal were sufficient to build a waterworks. Although strict conditions governed the handling of the fund, by 1878, when the city began to make use of it, only some 200,000 pesos had accumulated, whereas had it been invested at 10 per cent compound interest for 135 years, it would have grown to about four billion pesos. This article will outline briefly the Manila Metropolitan Water District, its water consumption and allied matters, the original small supply system completed in 1882, the much larger aqueduct now under construction, together with filters and a storage reservoir to help out the summer shortage until the new or Angat River supply is available.

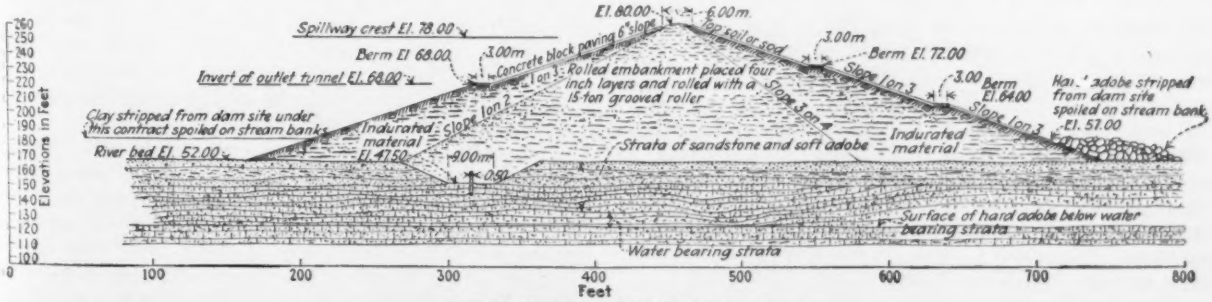
Manila and three small suburbs form the Manila Metropolitan Water District. The population of the district is 363,000: Manila, 320,000; Pasay, 24,000; San Juan, 9,000. The total water consumption averages 23 m.g.d., of which all but 0.5 m.g.d. is used in Manila. The consumption is increasing at the rate of 0.5 m.g.d. each year.

Although the consumption is 100 per cent metered, 35 per cent of it is unaccounted for. Of the 65 per cent recorded, 41 per cent is sold to the general public and 24 per cent to the government. The meter rate is 9½c. per 1,000 gal., but users with sewer connections pay 4¾c. additional. There are 123 miles of mains and 21,400 services.

SITE OF ANGAT DIVERSION DAM FOR MANILA WATER-WORKS
The Angat River has a minimum recorded flow of 80 m.g.d., all of which it is proposed to take eventually. The dam will be of cyclopean masonry, 35 ft. high.

Earlier Supply—In 1882 the Santolan pumping system was completed. It consisted of two 2-m.g.d. pumps, about 7 miles of 26-in. cast-iron force main and a 14-m.g. distribution reservoir (El Deposito). Two pumps were added in 1898.

In 1910 the Americans completed the gravity system from Montalban. It was built under the direction of J. F. Case and Clarence W. Hubbell, with Desmond FitzGerald as consulting engineer. It cost $2,500,000, gold, and is Manila's present supply. The principal features are a masonry dam at Montalban, 10 miles of 42-in. steel pipe siphon, 5 miles of 58x58-in. horseshoe grade



CROSS-SECTION OF ANGAT DAM
Red clay in center, indurated material on both outer parts.

tunnel and a 50-m.g. distribution reservoir at San Juan.

The capacity of the Montalban aqueduct is 23 m.g.d., but from January onward the discharge of the Montalban River drops until just before the rains in May, when the flow is from 3 to 10 m.g.d. for from one to ten weeks. The old Spanish pumping station at Santolan is then put into operation and contributes from 6 to 8 m.g.d. Flashboards 16 ft. high at the Montalban dam are to be tried for the first time this year (1928). They will increase the storage capacity to 485 m.g. Leakage around and under the dam reduces the available storage capacity by a large but unknown amount.

ANGAT AQUEDUCT IN CUT AND COVER
Reinforced concrete, 5.74 ft. high by 5.904 ft. wide.

New Supply—Due to delays in getting a new supply, not only does the city now use all the water that the Montalban pipe line can deliver but nearly every year brings a longer or shorter period when the river discharge (augmented by water stored behind the dam) is less than the pipe capacity. The new supply will come from the Angat aqueduct, now under construction, to a junction with the Montalban aqueduct. The higher head of the water delivered at this junction will increase the capacity of the Montalban aqueduct from 23 to 39 m.g.d. When the consumption reaches the latter amount, the new aqueduct will be extended parallel to and above the present one and the sides of the San Juan reservoir will be raised so as to give more pressure in the city. The minimum recorded discharge of the Angat River is 80 m.g.d. and the tunnel and cut-and-cover section of the aqueduct will discharge that quantity. Nearly all siphon sections will be duplicate pipe lines of 40-m.g.d. capacity each—one pipe at first and the other when needed.

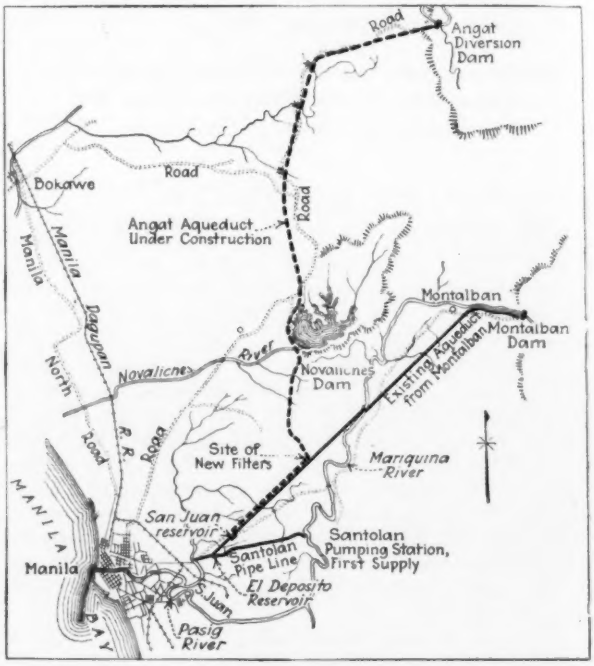
Diversion Dam—The Angat diversion dam will be 35 ft. high, of cyclopean masonry gravity section. No storage is needed. The river is very flashy. It has risen 60 ft. in six hours.

Angat Aqueduct—The Angat aqueduct is 19.3 miles long, with 9.5 miles of tunnel (4 miles in andesite rock and 5.5 miles in adobe), 3.7 miles in cut and cover and 6.1 miles of siphon, both of the latter in earth and adobe. An access road parallels the aqueduct. The tunnels in adobe have a 6-in. lining. No machinery is used in driving them. Drilling is by hand. A few shots loosen up the material and it can be trimmed to exact lines with picks. The 4-mile andesite tunnel is being driven from the portals only. Air equipment is used, with Diesel engines for power. The siphons are reinforced concrete up to a head of about 50 ft.; above that head, mortar-lined and concrete-covered steel tube will be used. A strain of 9,000 lb. per sq.in. was allowed in the hoop steel in the siphons and they have proved practically watertight under test. The cut-and-cover sections are of reinforced concrete. The small increase in cost over plain concrete was warranted as a protection against earthquakes.

Filtration Plant—Rapid sand filters are provided for in duplicate sets of units of 40-m.g.d. each. One set is now under construction and the other will be built when the consumption demands it.

Novaliches Dam and Reservoir—To increase the supply as soon as possible, the Novaliches dam was appended to the Angat project. It is an earth dam on a small stream 3.8 miles from the junction of the Angat and Montalban aqueducts, and on the Angat line, with a drainage area of 10 square miles. Its object is to store the rainy season runoff and release it during the dry seasons of the years required to complete the Angat aqueduct. The reservoir will hold 9,000 m.g., of which 7,000 m.g. will be available. The dam is 95 ft. high and contains 640,000 cu.yd. The contract price is 45c. per cubic yard for red clay and 80c. for indurated material.

The red clay has the following mechanical analysis: Sand, 0.25 to 1 mm., 0.4 per cent; and 0.05 to 0.25 mm., 4.9 per cent; silt, 0.005 to 0.05 mm., 4.27 per cent; clay less than 0.005 mm., 52.0 per cent. The indurated material



SUPPLY SYSTEM OF THE MANILA METROPOLITAN WATER DISTRICT
The Santolan supply was introduced in 1882 and the Montalban in 1910. The Angat addition, now under construction, includes a diversion dam, an aqueduct and a filter plant. To supplement the storage pending the completion of the Angat aqueduct a storage reservoir is being built at Novaliches.

is volcanic tufa, locally known as adobe. It is part sand and part clay and varies greatly in hardness. Both materials are excavated by steam shovels, hauled in 3-ton trucks and rolled in 4-in. layers by a 15-ton grooved roller. A three-barrel concrete arch conduit carries the stream under the dam during construction.

Cost—The total cost of the new work being done, including extensions of the distribution and sewer systems, will be $8,500,000 and will be paid from the proceeds of bonds sold in the United States. Contracts totaling $4,000,000 have been awarded. A. Gideon is manager for the board of directors of the Manila Metropolitan Water District and A. D. Williams is consulting engineer.

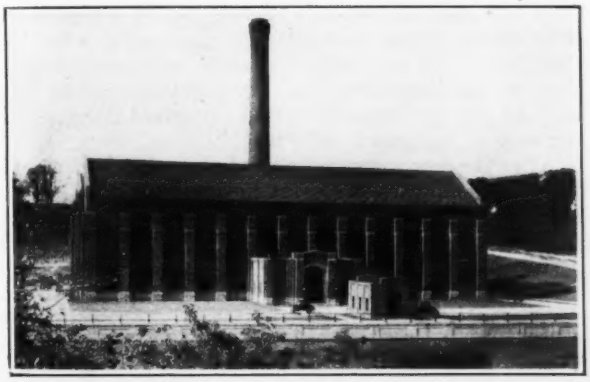
New Pumping Equipment for Milwaukee Water-Works

Pumping Capacity Increased by Three 400-Hp. Two-Pass Boilers, a 25-M.G.D. Triple-Expansion Pump and a 40-M.G.D. Steam-Turbo Centrifugal Pump

By Herbert H. Brown
Engineer in Charge of Design and Construction of Pumping Stations, Milwaukee, Wis.

Pioneer in the use of the triple-expansion high-duty pumping engine and a persistent supporter of the type, with a dozen in use, Milwaukee has joined the majority by installing a large centrifugal unit at a pumping station already having four triple-expansion pumps with space for two more. It has also been keeping pace with progress in boiler equipment. It is significant of the times that Milwaukee has an engineer in charge of the design and equipment of pumping stations. —Editor.

When Milwaukee placed the Riverside pumping station in operation, in July, 1924, it was equipped with machinery which developed only half of its proposed ultimate capacity. Three vertical triple-expansion pumping engines were installed, two of 22-m.g.d. capacity under a 280-ft. head and the third of



RIVERSIDE PUMPING STATION, MILWAUKEE, WIS.

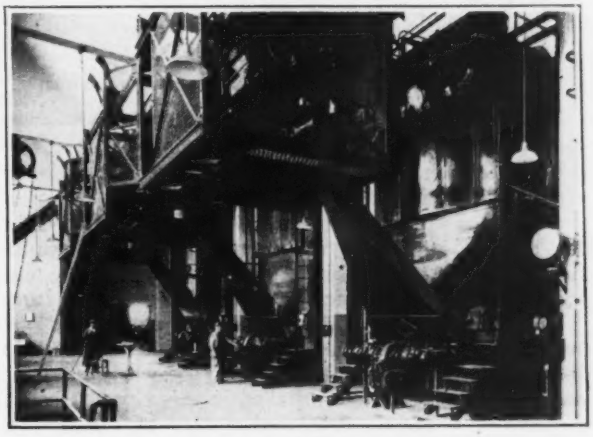
25-m.g.d. under 170-ft. head. In the boiler room three 400-hp. four-pass water-tube boilers were installed, with auxiliary equipment including underfeed stokers, convection type superheaters, soot blowers, forced-draft fans, oil-removal filters and water softeners. A pivoted bucket conveyor carries the coal to overhead concrete bunkers, from which it is spouted and weighed to each boiler.

The rapid growth of the city and the corresponding increase in demand for water during the past four years necessitated an increase in pumping capacity earlier than was expected. Three new 400-hp. two-pass boilers and a new 40-m.g.d. steam-turbine-driven centrifugal pump are the subject of this article, which is also designed to show the progress that is being made in the Milwaukee water-works.

Two-Pass and Four-Pass Boilers—In the boiler room three additional water-tube boilers of 400 hp. were installed during 1927. They differ from those of the original installation in being of the two-pass type, whereas those installed in 1924 were four-pass units.

Careful observation of the operating records of the four-pass boilers brought out three important facts: (1) They could not be operated at more than 165 per cent of rating; (2) there was an exceedingly large draft loss through the boilers; and (3) as heat-absorbing and transferring units we were well satisfied with their performance. Bearing these facts in mind, it was decided to design the new boiler units either with greater length between headers or else with only two flue-gas passes. Due to the limited floor space in the rear of one of the boilers, two-pass units were installed. They are equipped with superheaters of the convection type and with mechanical stokers.

Some of the more important results of the acceptance tests of these boilers (Dec. 28, 1927) are given in Table I. The tests show the flue-gas temperature 82 deg. higher and the CO_2 0.7 per cent lower in the two-pass than in the four-pass boilers. In spite of the handicap of higher flue-gas temperature, the over-all efficiency of the two-pass unit was 2.37 per cent higher than that of the four-pass boiler. This can be attributed only to a better absorption of the radiant heat of the fire in the two-pass boiler. The sloping bridge wall and corresponding longer length of tube surface exposed to the fire are features of the two-pass boiler which enable it



BOILER ROOM OF RIVERSIDE PUMPING STATION

to utilize more radiant heat and produce a higher efficiency, even though the temperature of the exit gases is considerably higher than that of the four-pass unit.

As far as capacity is concerned, the two-pass boiler has demonstrated its ability to handle such maximum loads as will be imposed upon the pumping station. On the official acceptance tests to demonstrate capacity, these boilers developed 223.5 per cent of rating for an average of six hours with a maximum of 263 per cent for a short period. During this six-hour test the average draft loss through the boiler was 0.37 in. of water when the boiler was developing 223.5 per cent of rating. From the test

figures given in the table, the draft loss through the two-pass boiler was 0.045 in. of water when the boiler was developing 105.8 per cent of normal rating. The draft loss through the four-pass boilers was 0.375 in. when the boiler was developing 109.5 per cent of normal rating and 0.74 in. at 156 per cent of normal rating. An analysis of the draft losses enumerated will indicate the No. 4, has a capacity of 25 m.g.d. when operating under discussion and show the extent of the improvement secured by changing from a four-pass to a two-pass boiler.

Reciprocating and Centrifugal Pumps—In the pump room a fourth vertical triple-expansion pumping engine was installed during 1927. This unit, known as pump No. 4, has a capacity of 25 m.g.d. when operating under 170-ft. head. The guaranteed duty was 195,000,000 ft.-lb. per 1,000 lb. of steam at 200-lb. pressure and with 100 deg. of superheat. At the official acceptance test a duty of 200,963 ft.-lb. was obtained with 199.25-lb. pressure at the throttle and 118 deg. of superheat. Correcting this duty to the steam conditions specified in the contract brings the final duty to 197,600 ft.-lb. per 1,000 lb. of steam, or 1.33 per cent above the guaranteed amount.

The most radical change in the type of equipment installed recently has been the selection of a steam-turbine-driven centrifugal pump to supplant the vertical triple-expension engines previously erected. It was only after a careful and lengthy study of the relative merits of each type of pump that this decision was made. In the fall of 1927 a contract was let for a 40-m.g.d. steam-turbine-driven geared centrifugal pump, which is now being erected and will be tested and in service by June.

TABLE I—RESULTS OF BOILER TESTS AT MILWAUKEE PUMPING STATION

Boiler heating surface, sq.ft.	4,040
Superheating surface, sq.ft.	1,005
Grate surface, sq.ft.	64.6
Draft	Forced draft fans
Fuel	Eastern bituminous
Heating value per lb. (dry), B.t.u.	13,823
Average CO_2 in flue gas, per cent	12.4
Average excess air, per cent	50
Vacuum over fire (inches of water)	0.063
Vacuum at boiler outlet, in	0.108
Pressure in stoker wind box, in.	0.942
Steam pressure (gage), lb.	208.5
Degrees of superheat in steam, deg. F.	81.1
Av. temperature of flue gases, deg. F.	499
Actual evaporation per lb. fuel as fired, lb.	9.70
Equivalent evaporation per lb. fuel as fired, lb.	10.72
Per cent of normal rating	105.80
Efficiency of boiler, superheater, furnace and grate (based on coal as fired), per cent	79.98

The vertical triple-expansion pumping engine has long been the standard of the Milwaukee water-works. In 1887 the first engine of this kind in the world used for water-works service was installed in this city. It had a capacity of 6 m.g.d., developed a duty of 118,186,000 ft.-lb. per 100 lb. of anthracite coal and was in service until 1924, when the booster station in which it was located was permanently shut down. In 1891 an 18-m.g.d. engine of the same type was installed. This pump held the world's record for efficiency, developing 154,048,704 ft.-lb. of work per 1,000 lb. of steam. This engine is still rendering excellent service after 37 years of continuous operation.

From 1891 until 1928 thirteen vertical triple-expansion engines were installed in the Milwaukee water-works. When the official acceptance test on pump No. 1 at the Riverside pumping station was run in January, 1925, the world's record for efficiency again returned to the Milwaukee water-works, a duty of 214,545,000 ft.-lb. per 1,000 lb. of steam being developed. To our knowledge no other pumping engine has surpassed this duty to date. We have now eight such engines in service at the North Point and four at the Riverside station.

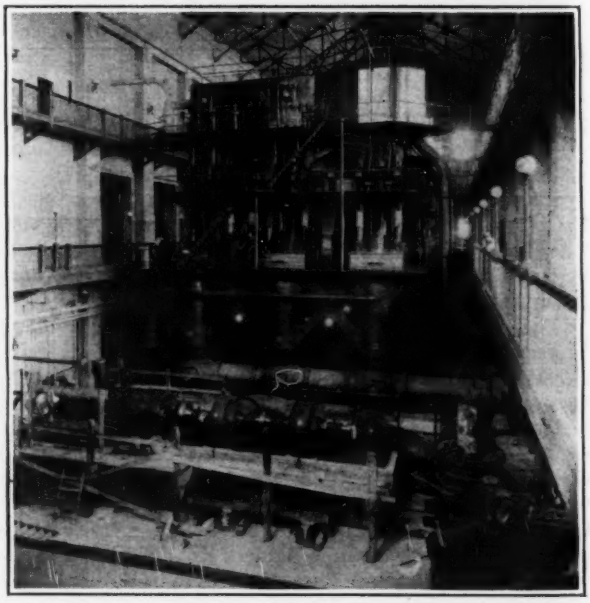
With this historical development and experience with vertical triple-expansion engines, with the economical handling of the present engines by our operating division and with the Riverside pumping station planned for two more such units, it took the courage of our convictions to change to a different type of pumping unit. However, it is commonly recognized that the vertical triple-expansion pumping engine has reached the zenith of its career. The tremendously large gains in efficiency developed in the turbo-centrifugal pump during the past ten years has narrowed the economy gap considerably between it and the triple-expansion engine. The original cost of a vertical triple-expansion pumping engine is very large and therefore it must operate against a high overhead charge. This fact becomes emphasized when the "use-factor" of the pump is taken into consideration. Because the "use-factor" of our pumping engines was only 50 per cent, it exercised an important influence on the type of equipment selected.

TABLE II—RIVERSIDE STATION PUMPING RECORD, 1927

Total pumpage for the year, m.g.	11,132.7
High service, m.g.	10,064.9
Low service, m.g.	1,067.7
Average pumpage for year, m.g.d.	30.5
Average head, ft.	265.563
Station duty, ft.-lb. per 100 lb. coal	145,093,412
Station duty, ft.-lb. per million B.t.u.	116,986,997
Thermal efficiency, per cent	14.45
Coal consumed, lb.	16,993,600
Coal to pump 1,000,000 gal. 1 ft. high, lb.	5.784
Average daily delivered horsepower	1,421.554
Coal per delivered hp.-hr.	1.364

After the new turbo-centrifugal pump has been placed in service and has been operated for a reasonable period, it will be the subject of an interesting study for comparison with the vertical triple-expansion engine as to performance and economy.

A few important statistics indicating the characteris-



NEW PUMPS FOR MILWAUKEE WATER-WORKS
In front of the new 25-m.g.d. vertical triple-expansion engine is the relatively small turbo-centrifugal pump of 40-m.g.d. capacity.

tics of pumpage at the Riverside pumping station during 1927 are given in Table II.

The new boilers were built by the Union Iron Works; the triple-expansion engine by the Allis-Chalmers Manufacturing Company, and the turbo-centrifugal unit by the De Laval Steam Turbine Company.

The design, purchase and installation of the new equipment have been by the direction and under the supervision of Roland E. Stoelting, commissioner of public works; Joseph P. Schwada, city engineer; H. P. Bohmann, superintendent of water-works; Ralph Cahill, formerly engineer-in-charge; and the writer. The operating division of the water-works, under the supervision of which such excellent results have been attained, has Ferdinand Krieger as chief engineer; Ernest Eggebrecht, assistant chief engineer; William Sieg, engineer-in-charge of the Riverside pumping station, and H. B. Hoefer, engineer-in-charge of the North Point pumping station.

Iron-Removal Plant for Water Supply of Albuquerque, N. M.

Lime and Alum Without Aeration or Mechanical Agitation—Filter Wash-Water Stored to Equalize Flow in Sewers

By N. T. Veatch, Jr.
Black & Veatch, Consulting Engineers,
Kansas City, Mo.

WATER-WORKS improvements now under construction at Albuquerque, N. M., include an iron-removal plant and a pumping station to be equipped with motor-driven low-service and steam-driven high-service pumps. The city has a population of 25,000, of which 23,000 are served by the water system.

Water Supply and Consumption—Wells intercepting the underflow of the Rio Grande River afford an ample and readily increased water supply. The water from the different wells varies considerably in iron, carbon dioxide and hardness, but the composite water has the following approximate characteristics: CO_2, 6 p.p.m.; iron, 0.5; temporary hardness, 200; permanent hardness, 100; total hardness, 300 p.p.m. The consumption averages 1.8 m.g.d., with a maximum rate of 2.7 m.g.d., which represent daily per capita rates of 91 and 136 gal. respectively. The estimated future population and consumption are as follows:

	1930	1935	1940
Population served	25,500	32,300	38,000
Av. consumption, m.g.d.	2.4	3.2	3.8
Max. consumption, m.g.d.	3.6	4.8	5.7

Water-Works Plant—At present water from the wells is pumped to a receiving well at the plant, near the center of the city, and is then pumped into the system (without treatment) either by a Holly-Gaskill crank-and-flywheel pump or by a motor-driven centrifugal pump. Elevated storage for part of the city is provided by an open 10-m.g. reservoir approximately 225 ft. above the pumps. Storage for the remainder of the city is provided by a second 3-m.g. open reservoir located 145 ft. above the lower reservoir. Water for the upper reservoir is pumped as needed from the lower one by motor-driven centrifugal pumps. The Holly-Gaskill pump, installed in 1884, is still being used for regular service and will be kept as a stand-by unit. It has been the main unit in the plant, and has probably taken care of at least 90 per cent of the high-service duty.

Treatment Works—In view of the relatively low carbon dioxide content of the water, 6 p.p.m., the customary treatment by aeration has been omitted, since the cost of the lime required to remove this proportion is less than that of the power required to operate an aerator. The plant is designed for a normal flow of 5 m.g.d. and consists of a lime-mixing tank, a settling basin, an alum-mixing tank and two filter units.

The lime and alum mixing tanks are circular, with hopper bottoms, affording a detention period of ten minutes. Water will enter through a tangential inlet and will be taken off through an outlet at the bottom of the hopper. Agitation for chemical mixing will be obtained by the motion of the water in flowing through the tank. The settling basin is in two units, each 40x35 ft. and 15 ft. deep. Their total capacity is 0.315 m.g., or about 1½ hours' flow. As the raw water is always clear, the object of this basin is merely to allow sufficient time for the reaction to take place between the lime and the carbon dioxide, plus the ferrous iron in the water.

The two filter units are each 23x19 ft. in plan, with an effective surface of 437 sq.ft. The piping is so arranged as to allow a flow of 4 g.p.m., or twice the normal rate, through the filters, which will be operated principally as roughing filters to intercept and precipitate any ferrous iron which may not have been changed to the ferric state in the basin. Alum will be added in small amounts before filtration to form a mat on the filter surface for clarification. The filtered water will be chlorinated and collected in a clear-water well, with a capacity of approximately one-hour flow, or 0.2 m.g. This well is to serve merely as a pump sump, since the main clear-water storage is at the upper end of the system, where a total of 15,500,000 gal., or approximately three days' supply, is provided.

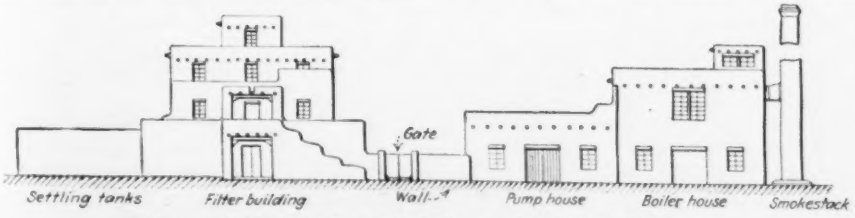


FIG. 1—WATER-WORKS STATION AT ALBUQUERQUE, N. M.
Pueblo Indian style of architecture with step-backs.

Since this plant will be located near the center of the city, the filter wash water will have to be handled through the existing sanitary sewers, which are too small to accommodate the flow while the filters are being washed. To equalize the flow, therefore, a storage tank with a capacity of five minutes at the maximum rate of wash has been provided, and the outlet is so arranged that the discharge from the tank will not gorge the sewers.

Pumping Station—There will be two 150-hp. horizontal return-tubular boilers and a crank-and-flywheel steam pumping engine of 4-m.g.d. capacity. The existing 3-m.g.d. steam pump will be connected to the new boilers and held for stand-by service. A 3-m.g.d. motor-driven centrifugal pump will be installed for emergency use. A feature of this station is the adoption of the Indian

Pueblo style of architecture for the pump and boiler house. This style is very popular and appropriate for a New Mexico city, although it may seem somewhat bizarre to the average water-works man.

Designers and Builders—Contracts totaling approximately $165,000 were awarded on Feb. 28, 1928: Buildings and concrete work, E. J. Marchant, Albuquerque, N. M.; 4-m.g.d. pumping engine, Allis-Chalmers Manufacturing Company, Milwaukee, Wis.; filter equipment, E. W. Bacharach, Kansas City, Mo.; boilers, Sterns-Rogers Company, Denver, Colo.; auxiliary equipment, Crane - O'Fallon Company and the Construction Machinery & Supply Company, Albuquerque; concrete chimney, J. V. Boland, St. Louis, Mo.; elevated steam wash-water tank, the Darby Corporation, Kansas City, Mo. Plans were prepared by Black & Veatch, consulting engineers, Kansas City, Mo., and the work is being done under their supervision. The architectural features of the buildings were worked out from designs submitted by Gaastra, Gladding & Johnson, Albuquerque, N. M.

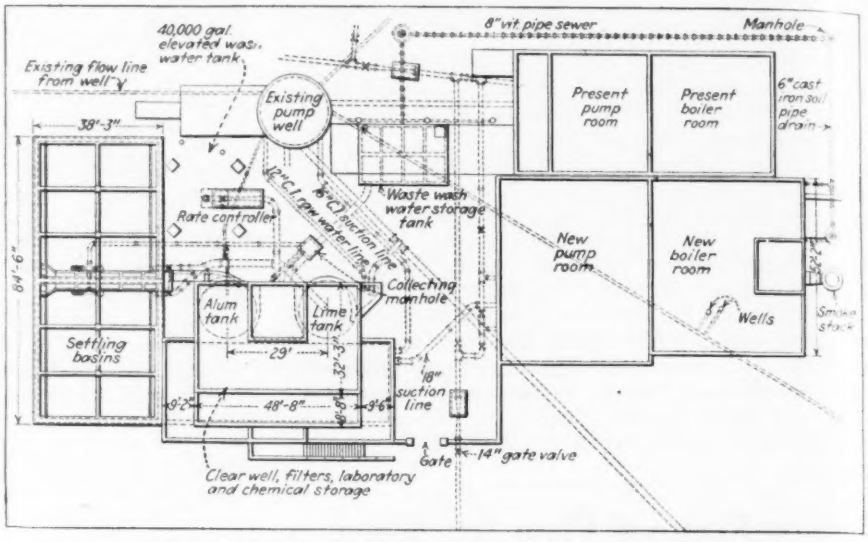


FIG. 2—LAYOUT OF WATER-TREATMENT WORKS AND PUMPINGSTATION, ALBUQUERQUE, N. M.

City With High Typhoid Rate Will Not Purify Water

Rhinelander Officials Are Willing, but the Residents Reject Engineers' Reports and Defeat Bonds for Good Water

WITH a polluted water supply, a high typhoid rate and an apathetic public opinion which results in continual defeat of bond issues for safer and better water, the sanitary conditions at Rhinelander, Wis., have for some time been highly unsatisfactory. The situation is the more serious in view of the fact that this town of 7,000 population is a center for tourist travel during the summer. The Wisconsin River, from which the supply is pumped directly to the mains, is polluted by human wastes from the employees of local lumber and paper mills and from hunters and campers, as well as by surface wash. The water is always of high color and turbid. Chlorinating apparatus was installed in 1920, but inspections have shown that it is not always in operation.

For thirteen years the city and the state board of health have been dealing with this problem, but as yet without result, although frequent inspections and reports have been made by the board and three consulting engineers have been engaged by the city at different times. In 1919 the state authorities issued an order for the city to develop a new water supply which would be adequate and sanitary. But bond issues for this purpose were defeated in 1920, 1924 and again in April, 1928. It may be necessary to devise some other method of financing.

Public meetings were held in March, 1928, at which L. F. Warrick, state sanitary engineer, described the situation and the pressing need for adequate protection of the local water supply, from the aspects of public health and the economic value of a pure water supply. For financing the improvement, an issue of mortgage utility bonds was proposed. In the open discussions the chief objections were the use of meters, apparent lack of water-borne diseases and resentment against the state board of health for ordering improvement.

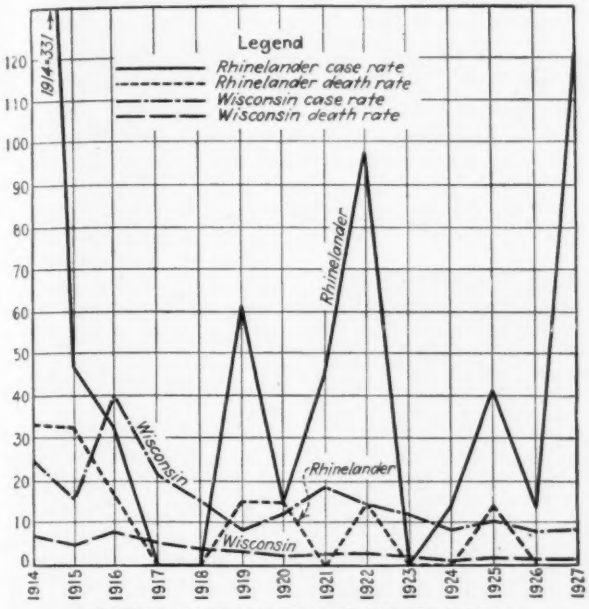
The accompanying diagram shows the very high typhoid case and death rates at Rhinelander and the much lower figures for the State of Wisconsin. A recent report by Mr. Warrick shows that the city's public water supply is unsafe for domestic consumption during a good part of the time. Of 92 analyses made by the State Laboratory of Hygiene at Madison and its branch laboratory at Rhinelander during the past eight years, twenty (approximately 22 per cent) were unsafe. In 1924 seven of the nine analyses made showed the water unsafe. During the summer of 1927 only two of eleven analyses were reported safe. The water is highly colored and turbid at practically all times.

Although there have been no serious epidemics of typhoid fever since 1914, typhoid is always present to a greater or less extent, there having been a total of eight deaths from this disease since 1914, which is far in excess of the average rate for the state. These deaths have not been traced definitely to the public water supply, but in one instance at least the deputy state health officer believed that the water supply was the primary cause of four or five cases. Chlorination, the only treatment now being applied, cannot be depended upon under all conditions and at all times to render the supply safe, because of the varying organic content and intensity of pollution. Furthermore, it in no way improves the physical character of the water with reference to color and turbidity.

With the increasing population on the Wisconsin River above the water intake, particularly during the summer months, when thousands of tourists visit this section, the danger of serious contamination of the water supply is increasing. The latest proposed plan was for a 3-m.g. filter plant with settling basin, mixing flume and aerator, and clear-water basin. At the 9-m.g. filter plant installed by the Rhinelander Paper Company in 1927 about 70 per cent color removal is effected with 2 grains of alum per gallon, a filter rate of 3 gal. per square foot

per minute and a 30-minute detention period. No lime or soda ash is used. At this plant the raw water shows carbon dioxide 6 to 7 p.p.m. and alkalinity 25 to 30 p.p.m., while the treated water shows 10 to 12 and 16 to 20 p.p.m. respectively.

Indications are said to point to further indecision and



TYPHOID CASE RATES AND DEATH RATES

delay by the city. What action the state board of health will or can take to enforce its order for more sanitary conditions is dependent upon a decision of the attorney-general as to the powers of the board in this respect, the question having been referred to him in April, 1928.

Local Company to Finance New Municipal Water Supply

A new water supply, to be provided by a municipal company on account of the city's bond-issue limit but to become city property eventually, is proposed for Bloomington, Ill., which has a population of 30,000. The present supply, from wells in the glacial drift, is generally adequate in quantity, although there has been a shortage at various times. The extreme hardness of this water is the main cause of a demand for a new supply, the water containing about 800 p.p.m. of total hardness, about half of which is sulphite hardness. At present it is given no treatment. Practically all homes have cisterns, and there are some individual softeners.

The plan proposed is to build a storage reservoir on Money Creek, a branch of the Mackinaw River, about 13 miles north of Bloomington, filter and soften the water and deliver it into the present city reservoir. The creek water has about 250 p.p.m. of total hardness, which it is planned to reduce to about 100 p.p.m. The work involves an earth dam, a 1,500-m.g. reservoir, 14 miles of 24-in. pipe, a pumping station and a softening and filtration plant. As the estimated cost, $1,200,000, exceeds the city's bonding limit, a method of financing by the organization of a local company has been developed, similar to that employed at Decatur, Ill. (*Engineering News-Record*, Feb. 17, 1921, p. 299). The Citizens Water Supply, Inc., is the name of the company, composed of about 25 leading business men of Bloomington and Normal. It is thought probable that some securities will be sold locally and the remainder of the required money obtained from a general sale of bonds. The plan is to pay off the cost within 30 years, by increased water rates, whereupon the plant will become city property.

It is proposed to deliver the water to the city at a wholesale rate and to have the city deliver it to the consumers, by means of the present high-lift pumping plant. Before the water company can proceed it must have a contract with the city for the use of water. For this reason it has presented to the city a tentative agreement which, if accepted, is to be incorporated in an ordinance. The city council has since decided to have a report made covering costs, rates and the general practicability of the project. That report is being prepared by Black & Veatch, consulting engineers, Kansas City, Mo. The engineers for the water company are Taylor & Woltmann, of Bloomington, who have associated with them the Chicago firm of Alvord, Burdick & Howson, consulting engineers.

California Water-Chlorination Survey Shows Steady Growth

By C. G. Gillespie
Chief, Bureau of Sanitary Engineering, State Department of Health, Berkeley, Calif.

CHLORINATION in California began in 1915 with installations at seven water-works plants having a total average water consumption of 41 m.g.d. A chlorination survey as of Jan. 1, 1928, showed 68 water-works with chlorination plants, supplying 107 communities. The 68 works have 110 chlorine installations, of which eight treat well water and the remainder surface water taken either directly from streams or else from reservoirs. All or nearly all of the water supplied by the 68 water-works to an aggregate of 3,185,000 consumers is chlorinated, the total volume treated being 470 m.g.d. The total number of works in the state is 662, supplying 4,340,000 people.

The increase in chlorination has been steady, but with more rapid advance in the last few years. Starting with seven works in 1915, the number of works adopting chlorination averaged 4.7 for the eleven years 1915-25, eight for the three years 1924-27, but in 1927 alone sixteen began chlorination. The volume of water coming under chlorination in 1915 was 41 m.g.d. The largest yearly additions were 125 m.g.d. in 1924 and 151 m.g.d. in 1927.

Scarcely any of the early installations were in the southern part of the state. Since 1924, the distribution was about the same, north and south, but in 1927 the southern part led.

Classified by populations which the 68 water-works supply, fourteen supply from less than 500 to 1,000, nineteen 1,000 to 5,000, fourteen 5,000 to 10,000, twelve 10,000 to 50,000, five 50,000 to 100,000 and four more than 1,000,000 each. By ownership, 37 of the works are privately and 31 publicly owned.

Of the 68 works, 29 have a bacterial laboratory of their own, and of these thirteen make B. coli tests and sixteen stop with an agar count before and after chlorination. Frequency of sampling ranges from several times a day to once a week. For works not having a laboratory, bacterial control is through state or local laboratories and is infrequent.

Twenty Years as a Water Commissioner in a New England Town

By Charles W. Sherman
Consulting Engineer (Metcalf & Eddy), Boston, Mass.

TWENTY years ago, at the "March meeting" of the town of Belmont, Mass., I was elected a water commissioner for a term of three years. As I have been regularly re-elected, without opposition, presumably I shall be continued in office as long as I am willing to serve. Water commissioners in our town have almost invariably served for long terms. Late in 1925 one of my associates died in office after a service of 27½ years; a few months ago another, after nearly nineteen years of service, resigned to accept employment which was inconsistent with membership on the board.

A few words of description of New England town government may be appropriate, as it is not generally understood in other parts of the country. With us a "town" is both a geographical area and a municipal corporation occupying that area. The boundaries are usually irregular, and the extent may be almost anything from, say, 1 to 100 square miles. The government of the town is in the hands of its citizens; all appropriations and matters of policy are determined by the voters in town meeting. The administration of most town business, pursuant to the instructions of the town meeting, is in the hands of a board of selectmen. Specialized matters are usually in the hands of boards or committees elected to administer them. Educational affairs are always administered by a school committee, and municipal water-works usually by a board of water commissioners.

Charles W. Sherman

Belmont has an area of 4.6 square miles, and is but 7 miles from Boston. It was established as a town in 1859, from parts of three surrounding towns. It was a rural community, devoted largely to market gardening, but contained several large estates of wealthy men. In 1885 it was authorized by the state legislature to construct a water-works system, which it did in the years 1887-89, arranging with the water company serving one of the adjoining towns to furnish the water supply (from driven wells) and to operate the distribution system built by the town. At the end of 1889 there were about 9.6 miles of main pipes and 150 services. As was usual at that time, all water was sold by fixture rates; but the installation of meters began in 1893, and by 1898 the system was completely metered. In 1898 the Metropolitan Water Works began to supply water to the communities of the Metropolitan Water District, including Belmont, and at that time the town began to operate its distributing system and, as noted above, to sell all water by meter.

At the beginning the policy was established to lay no main pipes smaller than 6 in., except for temporary mains to furnish domestic supply in localities where the provision of a cast-iron main did not seem justified; in such places 2-in. galvanized wrought-iron pipe has been used.

When I became one of the commissioners in 1908, the town had a population of about 5,000; there were 21 miles of main pipe and 800 services; the water-works debt was $28,000 and the annual revenue $18,000. The construction cost had been about $130,000. The works were self-supporting. Out of revenue we were paying all operating expenses, including the assessment for Metropolitan water; all debt interest and retirement charges, and all ordinary extensions. Twice before 1920 it became necessary to borrow money for extensions: $10,000 in 1909 and $17,000 in 1913. Following the close of the war, however, the town began to grow with extreme rapidity. Farms and large estates were subdivided and considerable extensions and reinforcements have been required. This has necessitated borrowing large sums each year—as much as $60,000 in one year. At the present time the town has a population of about 18,000; there are about 51 miles of main pipes and 3,500 services; the construction cost has been in excess of $500,000, and the water debt is about $185,000; the annual revenue is about $85,000.

Water is furnished to the town by the Metropolitan Water Works, administered by a state commission. In effect, the state acts as trustee for the cities and towns making up the Metropolitan Water District, which eventually meet all the costs. The total cost of Metropolitan water for each year is computed by the state treasurer, including operating costs, bond interest and bond retirement charges, and this sum is assessed to the cities and towns, two-thirds in proportion to their water consump-

tion and one-third in proportion to their valuations. As the total annual cost does not vary directly with the total consumption and as the average basis of assessment changes from year to year, the average wholesale cost of water is not uniform nor the same to the several communities for any particular year. At the present time about $70 per million gallons is the average cost to Belmont.

About 75 per cent of the total consumption is accounted for by customers' meters. We are not proud of this record. With every service metered we should do better; but we have been growing so rapidly that we have not controlled the consumption as well as we should. It is our policy to take out and clean every meter at least once in six years—once in four would be better. All meters are supposed to be read every two months; bills are rendered semi-annually.

With the exception of a small amount of 2-in. pipe, our distribution mains are all of bell-and-spigot cast-iron pipe, from 6 to 12 in. in diameter. For the past five years we have laid only deLavaud centrifugally cast pipe. This pipe is more susceptible to injury by rough treatment in handling and laying than is sand-cast pipe. After paying for all breaks in deLavaud pipe, the saving in cost as compared with sand-cast pipe is substantial. This might not be so if larger sizes of pipe were involved, in which case the large quantities of water escaping from breaks might do material damage.

At present we are laying cement-lined cast-iron pipe, because tuberculation in ordinary cast-iron pipe proceeds rapidly with our soft Metropolitan water. Joints are usually made with leadite or hydrotite.

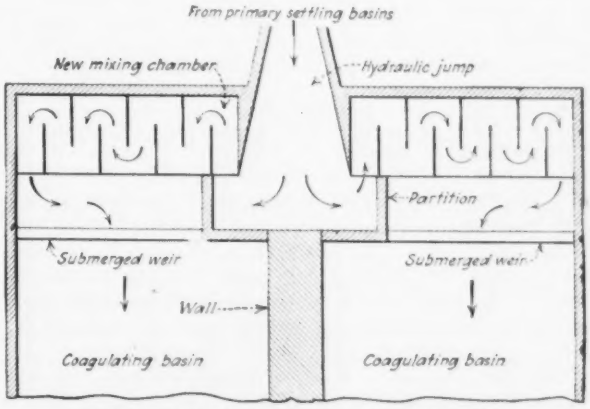
Most of our main pipe has been laid by day labor. Individual extensions have usually been short, and we have thought it more satisfactory and little more expensive to lay pipe in this way than by contract.

Cement-lined wrought-iron pipe has been used for most of our services; for a few years a former superintendent, who was allowed to use his own judgment, used 1-in. galvanized wrought iron, arguing (correctly) that they would give no trouble during his term of service. The original services, put in by the same man, were cement lined, and they have given practically no trouble. After continuing this practice for twelve or fifteen years, he changed to galvanized pipe, as noted, and the pipes are giving us plenty of concern. We shall eventually have to replace them by cement-lined pipes. We use lined couplings and fittings. We line our own service pipes, mostly during the winter, utilizing our permanent men whom we find it necessary to keep for maintenance work. The cost is less than that of commercial cement-lined pipe. We do not get quite so smooth a lining, and it may not be so good in other respects, but we find our lined pipes satisfactory in service.

And finally, the most important item in the successful operation of such works is the superintendent. In the 40 years since our works were started we have had but two men in this position, both excellent men. John H. Perkins, still living but retired, served from 1887 to 1910 and all the early development of the works was carried on by him. The only serious mistake he made was to abandon cement-lined services in place of galvanized pipe for a few years. The present superintendent, Edward T. Looney, is one of the best practical men whom it has ever been my fortune to know. Starting as a laborer, he became meter inspector and upon the resignation of the former superintendent was chosen to succeed him. He is a man of the highest integrity, excellent judgment, and complete devotion to his work. With an executive officer like him, the work of the commissioners has been much easier and simpler than it would otherwise have been.

Mixing Chambers Being Added to Hannibal Filter Plant

MIXING chambers are being added to the water-filtration plant of Hannibal, Mo., to give additional time for the chemical reaction. In the present installation, water from the primary settling basins passes to a hydraulic-jump mixing flume, at the tail of which water divides and flows through submerged weirs into two coagulating basins. As this arrangement does not give sufficient time for complete reaction, two mixing chambers (see sketch) of the conventional type are being built, in which the water will flow over, under and around wooden baffles so as to give a ten-minute mixing period with a velocity of 0.2 sec.-ft. at the maximum plant capacity of 6 m.g.d. The water from the tail of the flume will divide as before, but will pass first through one or other of the mixing chambers before reaching the channel from which it passes through the submerged weir into the corresponding coagulating basin. Partitions or bulkheads will be built across the weir chambers to divert the flow from the flume into the mixing chambers as shown. This improvement was designed by Burns & McDonnell, consulting engineers, Kansas City, Mo., and was built under the direction of Edward E. Wolfe, superintendent of water-works.



NEW MIXING CHAMBERS, HANNIBAL, MO.

Water-Works Extension Program at South Bend

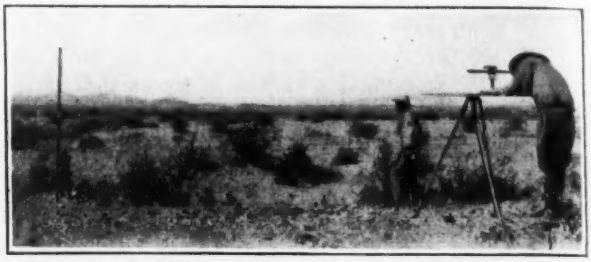
For 1928, South Bend, Ind., has a program for increasing the water supply by sinking three more wells and providing additional pumping plant. Next year a 0.25-m.g. elevated tank will be built to provide better service for a section of the city which is about 100 ft. above the general level. Later, it is planned to build a 6-m.g. reservoir into which the pumps will deliver and which will give a gravity service to the city, in place of direct pumping. The total cost of these improvements will be some $500,000, about half of which will be required for work in the next two years. It is intended to carry out the program gradually so as to avoid loans. B. J. McCaffrey is superintendent of water-works.

Colorado River-Los Angeles Aqueduct Project

Nearly a Million Dollars Thus Far Spent on Surveys and Office Work—Further Progress in Bringing 1,500 Sec.-Ft. 297 Miles Hinges on Storage and Power Cost

By H. A. Van Norman and E. A. Bayley
Assistant Chief Engineer and General Manager, and Assistant Engineer in Charge of Field Engineering, Respectively, Bureau of Water Works and Supply, Los Angeles, Calif.

The Insatiable Demands for water to meet the needs of our large and rapidly growing cities is strikingly illustrated by Los Angeles. Having gone far to the north for an immense gravity supply, the city soon found it necessary to reach still farther away for more water, this time easterly to the Colorado River. A distance of nearly 300 miles must be traversed and a head of some 1,400 ft. overcome by the proposed Los Angeles-Colorado River aqueduct, designed to carry 1,500 sec.-ft. of water, or nearly a billion gallons a day. The survey and other investigations preliminary to starting construction were of such magnitude and complexity as to require a bond issue of $2,000,000—enough to provide an entire water supply of a city of considerable size. The survey is described and the project outlined in the following article. —Editor.



TOPOGRAPHERS AT WORK ON THE DESERT
Typical of the hot, dry plain traversed by most of the proposed route.

RAPID growth in Los Angeles and neighboring cities has called for correspondingly speedy development of the utilities that serve it, and although a great water-supply development that brought water 250 miles from Owens Valley was completed only fifteen years ago, the city has again advanced to the point where another and still greater water supply must be provided. Because of the time required for construction, an early beginning on the new project is necessary if the city is to forestall a water shortage.

The water situation in Los Angeles for approximately 50 years has been studied closely and continually by William Mulholland, chief engineer and general manager, Bureau of Water Works and Supply, and when he pointed out the need for a new source, a bond issue of $2,000,000 was promptly voted in 1925 for investigations and surveys. With these funds a study of all available sources and, later, extensive surveys and preliminary plans for the Colorado River aqueduct have been carried out. This proposed aqueduct, about 300 miles long, has been designed for an ultimate capacity of 1,500 sec.-ft. (970 m.g.d.), or enough to supply the Los Angeles metropolitan water district for the next 50 years. Preliminary work on this project, an outline of which appeared in *Engineering News-Record*, April 2, 1925, has now reached a point where not much more can be done until the proposed Colorado River storage and power project has been put on a more definite basis.

The present population of the territory whose water service is supplied by the Los Angeles Bureau of Water Works and Supply is about 1,230,000 and the increase has averaged more than 70,000 per year for the last ten years. At this rate, and allowing for the maximum economical development of all present water resources, the city will reach the limit of its present supply within ten years. Because of low flow in times of drought, dependence cannot be placed on any material increases in the supply from Owens Valley. In the four-year period of 1923-26, for example, only 88 sec.-ft. would have been available in addition to the 400 sec.-ft. capacity of the existing aqueduct.

Underground water storage in the coastal plain near

A PLANE TABLE VANTAGE POINT ON THE DESERT
This is typical of the dry, rocky country over long stretches of which the aqueduct must pass.

Los Angeles has been steadily depleted by pumping. In fact, some of the smaller communities that have only the underground sources on which to draw have a more acute water problem than the city itself and are eager to join in some general scheme. The metropolitan water district act passed by the California Legislature in 1927 is a general enabling act, but was framed with particular reference to the needs of southern California communities in preparing to join in the development of a Colorado River water supply.

The measure authorizes four or more municipalities, whether contiguous or not, to join in the formation of a metropolitan water district for the purpose of development, storage, conservation and distribution of water for domestic purposes. A district so formed would have the usual powers of a municipal corporation. One city, according to the provisions of the act, may initiate the move for the formation of the district, after which, if the move is approved by the legislative bodies of other cities, the final decision about joining is made by the voters of each city at a special election.

AQUEDUCT SURVEY CREW IN CAMP
Because of extremely high temperatures, abbreviated costumes were in order wherever rocks and cactus permitted.

If the Colorado River aqueduct is carried forward as is now expected under the metropolitan water district plan, the cost will be apportioned among the various municipalities that join, on the basis of the assessed valuation. Some 38 cities and towns have indicated, through their elected officials, an interest in the plan, although final decision as to joining will have to be made at a special election.

An investigation of the comparatively few sources of supply that might be available for Los Angeles early led to the decision that the Colorado River is the only adequate, dependable supply within reach. Because all low water flow of that stream is appropriated, the only available supply is in flood waters. The city therefore made filings in June, 1924, on 1,500 sec.-ft. (970 m.g.d.) of surplus flow, to be diverted when flood storage is provided. Hence, until Boulder Canyon dam or some other dam that will store flood waters is constructed, the city cannot divert water from that source.

Colorado River water has an average hardness of 251 p.p.m., and while this is more than that of Owens River water, it is well within satisfactory limits. In fact, water pumped from wells on parts of the present water-supply system has a hardness of 351 p.p.m. As to possible contamination by organic matter, the high rate of discharge in the Colorado River and the sparsely inhabitated area it drains make this risk less than in the case of any other available source. However, safeguards equivalent to those now in use by the city on its existing supply [chlorination now used—EDITOR] will be maintained, whatever the source of supply.

Since the first surveys on the proposed aqueduct were begun in 1923, 18,000 square miles of territory has been mapped on a scale of 10,000 ft. per inch, with contours plotted at 100-ft. intervals. Of this area, 1,250 square miles has also been plotted on a scale of 1,000 ft. per inch, with contours at 20-ft. intervals. Practically all of this territory was unmapped desert waste broken by rugged mountain barriers.

Topographical surveys were carried out on a plan very similar to the work of the U. S. Geological Survey, preceded by a triangulation control in which some 1,900 permanent control points were established, based on the Texas-California arc of the primary triangulation made by the U. S. Coast and Geodetic Survey.

These surveys include all territory traversed by any of the proposed aqueduct locations, and were carried from the Colorado River westward far enough to tie in with existing maps of areas near Los Angeles. To aid in visualizing the territory thus covered, a large relief map about 20x27 ft. in size was built up to accurate scale, showing all of the territory between the Colorado River and the city of Los Angeles. On this map are marked the several proposed aqueduct locations.

Topographic mapping was done by the plane table method, as many as fifteen parties being in the field at times. These parties often worked under great difficulties in rough and arid country where temperatures ranged up to 120 deg. F. in the shade. Methods and equipment had to be arranged to suit these conditions.

Numerous routes are being investigated, as diversion is possible at many points along the river. The shortest route is one which begins at an intake 15 or 20 miles up the river from Blythe, Calif. Between this point and Shaver's Summit a total difference of elevation of 1,400 ft. must be overcome, to which must be added friction head and other losses, depending on the most economic slopes that will finally be decided upon. This lift will be accomplished in stages at five pumping plants.

KEY MAP SHOWING EXISTING AND PROPOSED AQUEDUCTS, LOS ANGELES WATER SUPPLY

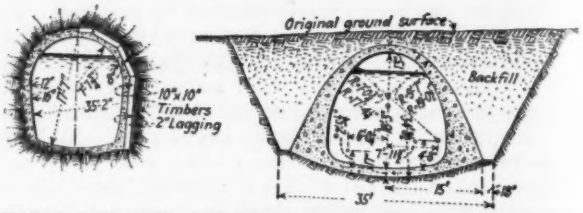
From Shaver's Summit westward the flow would be by gravity. All tunneling would be west of Shaver's Summit and would include about 35 miles of tunnel along the southwesterly face of the Little San Bernardino Mountains and a long tunnel under San Gorgonio Pass that might be anywhere from 13 to 29 miles long, depending upon the exact location of terminal storage and the final adopted gradient, which will be controlled by the price to be paid for power.

Other routes, some of which have been suggested by engineers not connected with the Los Angeles Water Bureau, would be considerably longer; one that would involve no pumping would have a total length of 750 miles, including about 200 miles of tunnels. A route 370 miles long would involve a 12-mile inverted siphon under a maximum head of 1,300 ft. Still other routes would involve considerable pumping lifts and by the use of generating plants would return part of the energy used. While these various locations have all been plotted and are receiving careful consideration, when they are compared as to cost, time required for construction and charges for operation and maintenance, the shorter routes appear to be the more economical.

In studying possible modifications of the various routes, in addition to considering the bare facts of location, gradient and lift, comparisons are being made of (1) the time required for construction, (2) the cost of various combinations of pumping plants if put in one unit at a time, (3) annual charges for energy used in pumping, and other elements that have a direct bearing on total operating costs over a long period of years. Whatever changes are made in the final location, the intent is to be able to deliver water into distribution reservoirs along the foothills near Los Angeles at about El. 1,200. Negotiations are now under way looking to the establishment of local storage and distribution reservoirs.

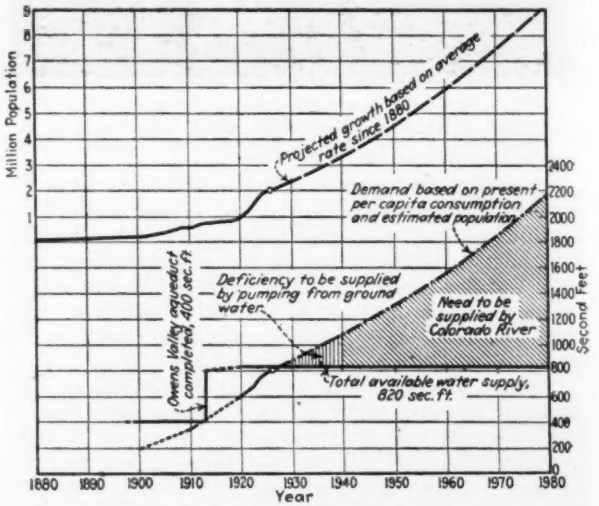
Final location, particularly with reference to the pumping plants, will depend so largely on the price of energy for pumping that only rough approximations can be made until this cost, one of the points at issue in federal consideration of the Boulder Canyon project, can be definitely established.

The question of the best way to get water clear enough for potable purposes out of the Colorado River has not yet been worked out to final conclusion, but studies of various possibilities have been carried on. Two miles of test canal has been built along the river near one of the proposed diversions to test the amount of clarification that could be obtained by infiltration into such a canal. An intake infiltration canal 8 or 10 miles long might also serve in part as a settling basin to be supplemented with a water supply pumped from shallow wells near by. Also a filing has been made on a dam site near Parker that would provide a settling basin for the removal of silt.

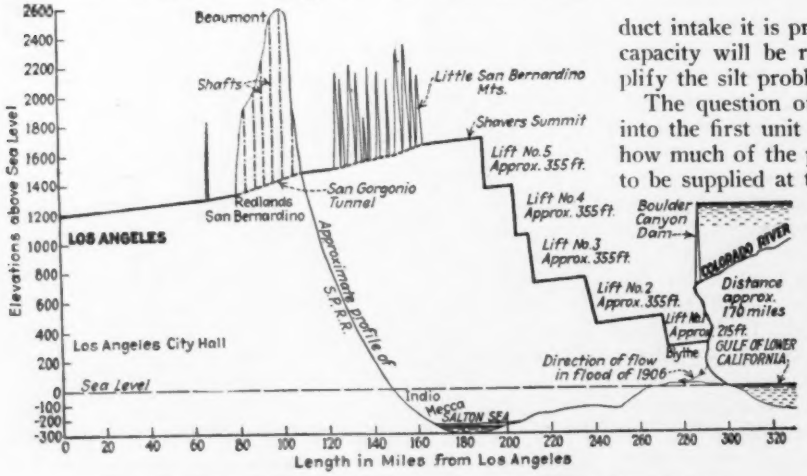


TYPICAL TUNNEL AND CONDUIT SECTIONS FOR PROPOSED COLORADO RIVER AQUEDUCT

Observations of the regulated flow in the streambed below Elephant Butte dam have indicated that the uniform flow of clear water from a storage dam does not pick up excessive quantities of silt, and this condition would doubtless also obtain below a storage dam on the Colorado. In the first few years of operating the aqueduct intake it is probable that only a part of the ultimate capacity will be required, which would materially simplify the silt problem.


Million Population
Second Feet
Year
Projected growth based on average rate since 1880
Demand based on present per capita consumption and estimated population
Deficiency to be supplied by pumping from ground water
Need to be supplied by Colorado River
Owens Valley aqueduct completed, 400 sec.ft.
Total available water supply, 820 sec.ft.

POPULATION AND WATER DEMAND CURVES, 1880-1980, LOS ANGELES METROPOLITAN DISTRICT
Includes all of Los Angeles County south of the Sierra Madre Mountains

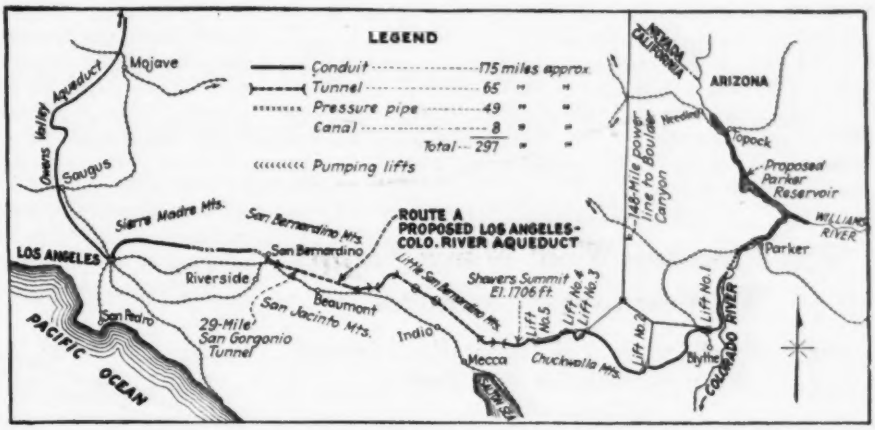


MAP AND DIAGRAMMATIC PROFILE OF SHORTEST ROUTE FOR LOS ANGELES-COLORADO RIVER AQUEDUCT

The question of how much water would be diverted into the first unit of the aqueduct depends largely upon how much of the proposed metropolitan water district is to be supplied at the outset. The initial quantity would probably not exceed 300 or 400 sec.-ft. The size of pumping units, steel pipe lines, siphons and flumes to be installed at the outset would be governed by the quantity of water needed immediately, while the main tunnels as well as parts of the line constructed as a concrete aqueduct would probably all be built to the ultimate 1,500-sec.-ft. size. However, some consideration has been given to making the tunnels as a long double-barreled line, the first unit of which

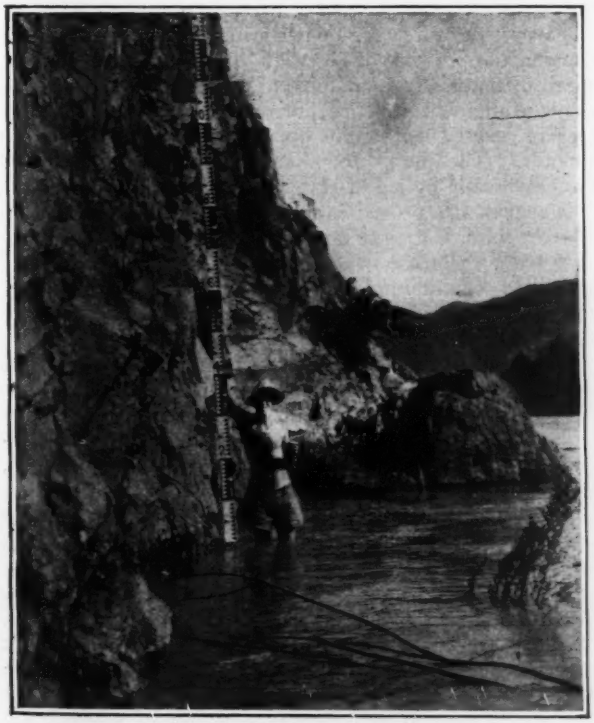
would cost about 80 per cent of the larger-sized single tunnel.

The shorter routes require a large block of power for pumping. Since the only available source of low-cost hydro-electric power is in or near Boulder Canyon, if this project is to be carried out a dam must be built on the Colorado River somewhere in the vicinity both for storage to develop water rights and for power. Developing the water rights is of utmost importance, it is believed, because there seems to be no alternative if a water shortage in the metropolitan area is to be avoided.



MAKE-UP OF PROPOSED NEW AQUEDUCT FOR LOS ANGELES

Power cost estimates have ranged from 2 to 4 mills per kilowatt-hour, and comparative power cost studies have been made for energy at 2.5, 3 and 3.5 mills per kilowatt-hour at a switchboard in Boulder Canyon. On the shortest route, indicated as route *A* on the map, p. 851, allowing for transmission line losses, pump efficiencies, etc., it is estimated that 278,247 hp. would be needed for pumping 1,500 sec.-ft. against the total head of 1,635 ft. on the shortest route. If the price for energy is 3 mills, the net pumping cost would be 1.94c. per 100 cu.ft., including operation, depreciation, maintenance, interest at 4½ per cent and, in short, all costs on power lines and pumping plants, but including no items chargeable to the maintenance and operation of pipe lines or the aqueduct itself. On this basis the annual pumping cost for the ultimate capacity of the aqueduct would be $8,409,000.



TAKING TOPOGRAPHY ALONG THE COLORADO
Desert surveys tied into river traverses at the points being considered for intake locations.

On the assumption of 3-mill power there would be five pumping plants working against almost equal heads, the highest lift being 360 ft. The studies being made in connection with these plants balance investment and operating costs as well as the higher cost of metal in pipe lines of large diameter against friction losses in smaller pipes.

Because of the numerous combinations of aqueduct location and pumping plant spacing, it was necessary to make various studies on each of the several routes and balance each one of these within itself before the different routes could be compared. The practice was to try out five average gradients on each route as applied to force mains, tunnels, conduits, flow lines and the various combinations thereof. Summing up the total estimated costs in the various departments has given a grand total estimated cost of the aqueduct that would deliver water to the city limits as between $150,000,000 and $200,000,000, this range being governed by the power cost and the changes in location and design, such as the length of tunnels, etc., dependent thereon.

The aqueduct section will vary in different parts of the full-capacity line from a circular section in the pressure conduits to rectangular sections in gravity lines. A considerable part of the route will consist of lined tunnels and monolithic concrete aqueduct, both of horseshoe section. The plan is to have the aqueduct covered for its entire length, partly on account of the danger of transverse floods in a region sometimes visited by sudden torrential flows.

The electric transmission line from the power house in Boulder Canyon to a switching station serving the several pumping plants on the shortest route would be 148 miles long, of which 115 miles would be a single tangent across the desert. This transmission line was figured for 220,000 volts and was estimated to cost $33,000 per mile. The total cost for power line and switching station was estimated at $7,980,000, including all interest during construction and other overhead items. Annual operating cost of the power system, including maintenance, operation, depreciation, obsolescence and interest at 4½ per cent, is estimated to total $589,000.

In working out aqueduct sections extensive studies are being made to determine an accurate value for n in Kutter's formula when applied to very large aqueducts. Tests made on the Owens Valley aqueduct indicated that the nominal value of $n = 0.014$ might be considerably

reduced for smooth conduit surfaces, and values as low as 0.0125 are being considered.

The project has been studied under the general direction of William Mulholland, chief engineer, and H. A. Van Norman, assistant chief engineer, Bureau of Water Works and Supply. E. A. Bayley has been assistant engineer in charge of field engineering, with S. L. Parrott directing surveys.

Small Surface-Well Water Supply With Automatic Control

Study of Well Inflow at Marengo, Ill.—Diagonal Reinforcement for Shell Sunk by Excavating

THE shallow-well water supply of Marengo, Ill., a town of 1,800 population, having become inadequate for fire demands, it became necessary to seek an additional supply capable of furnishing 450 g.p.m. instead of the existing maximum rate of 200 gal. The daily domestic consumption averages 95,000 gal., or 53 gal. per capita. The distribution system comprises about 6½ miles of 4- to 8-in. pipe for additional supply.

The comparative first and operating cost of sinking either glacial-drift wells 200 to 800 ft. deep or else large shallow surface wells, on the one hand, or on the other of building a storage reservoir was studied. This work included borings, tests on existing open wells, investigation of the slope of the groundwater and an estimate of the probable yield of both surface and artesian wells. From this study the curve given in Fig. 1 was developed showing the relation between well inflow and static head on the existing surface well, which was 20 ft. in diameter and 20 ft. deep. Tests showed that the yield of groundwater from the bottom of this well, which is in fine water-bearing sand and gravel, increased as the square root of the depth to which the water in the well was pumped below the outside groundwater level. In other words, the inflow in the bottom of the well followed the same law as that of inflow through many small pipes.

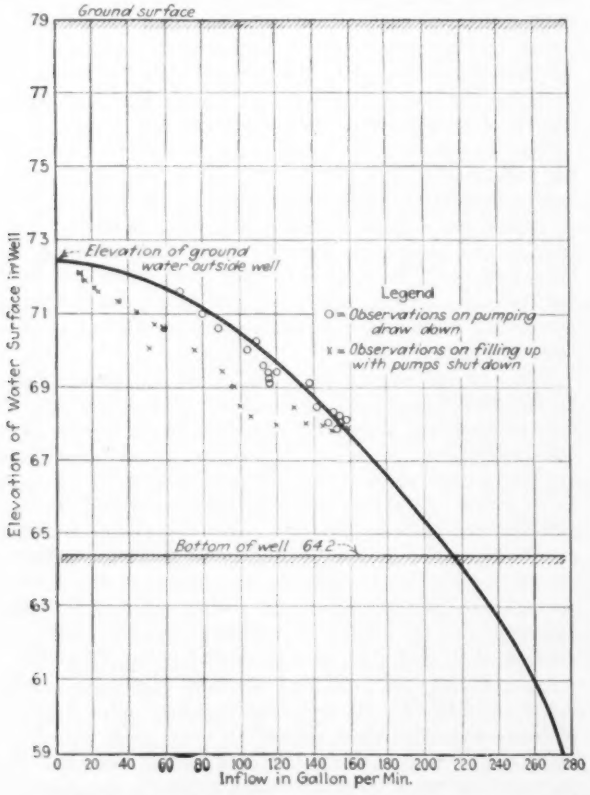


FIG. 1—RATE OF INFLOW IN PUMP WELL

After a comparison of eight possible projects for supply and distribution, a plan was adopted for an additional surface well 25 ft. in diameter and 23 ft. deep, located adjacent to the pumping station. This well was formed by building a reinforced-concrete shell above the ground and sinking it by excavation from the interior. The forecast of probable yield of water agreed very closely with the final test.

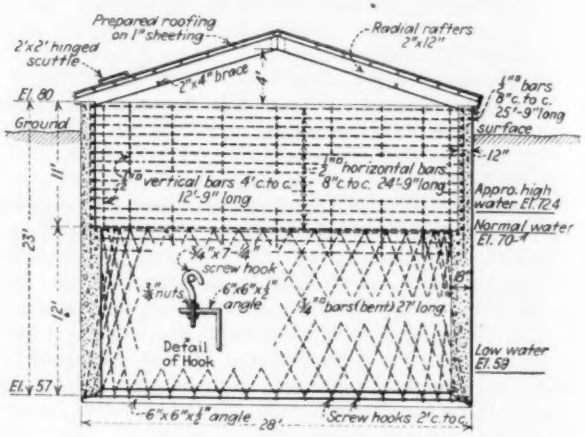


FIG. 2—CONCRETE WELL CURB
Note diagonal arrangement of reinforcement in lower portion.

An electrically operated centrifugal pump of 150 g.p.m. delivers the water for domestic purposes directly to the mains, the pressure of about 45 lb. per sq.in. being equalized by an existing standpipe of 6,300-gal. capacity. The new equipment for fire purposes consists of one 450-g.p.m. centrifugal pump operated by a 40-hp. electric motor. The pump for domestic service is controlled automatically by a self-starting pressure gage, which arrangement has proved satisfactory. Fire pressure of 80 lb. per sq.in. is thrown on by remote control of the pumping plant from the fire station. As a stand-by a 40-hp. gasoline engine and a second 450-g.p.m. centrifugal pump are provided. Daily inspection and oiling of the plant are done by the town constable.

A novel feature of the reinforcement of the concrete well curb or shell is that in its lower portion the reinforcing bars were placed in a diagonal position in order to take care of shearing stresses which might develop during the process of sinking. These were ¾-in. square bars, 2 ft. apart. For convenience in placing, the bars were bent in V-shaped pieces 27 ft. long and were attached to the bottom of the curb by means of hooks bolted to the 6x6x½-in. angle which constituted the cutting edge of the concrete curb. (See Fig. 2.) This arrangement of reinforcing, for which no precedent was found, is said to have served its purpose very efficiently. No cracks developed during the sinking process and the structure stood all of the strains due to unequal settlement caused by obstructions in one segment and lack of support for other segments of the circumference.

The investigations and plans were made by the Randolph-Perkins Company, Chicago, consulting engineers.

Trunk-Main Water-Distribution System for Greater Detroit

Low, Intermediate, High and Booster Pressure Areas to Be Served From One Central, Two Outlying and Several Booster Pumping Stations and From Elevated Tanks Through 504 Miles of 72- to 16-In. Trunk Mains

By Louis E. Ayres
Ayres, Lewis, Norris & May, Civil, Hydraulic and Electrical Engineers, Ann Arbor, Mich.

Confronted with a continuation of the recent rapid growth of its own and its outlying areas, the Detroit Water Department has entered on a notable program of water-works expansion to meet the needs of its metropolitan area. Four years' study of the problems begot by growth and a determination to meet it adequately are summarized in the following article, which is chiefly concerned with the trunk-main system already well under way to serve seven distribution areas but outlines also the pumping station system and mentions the large elevated tanks under construction and proposed. —Editor.

In September, 1921, when the population of the city was approximately 1,000,000, the Detroit Board of Water Commissioners, realizing that the then existing water-works system would soon be inadequate to meet the requirements of a rapidly growing metropolitan area, started a comprehensive survey of the entire water-works situation. During the succeeding four years exhaustive studies of every pertinent phase of the water problem were made by officials of the water department and by outside consultants, and in the fall of 1925 the board adopted a definite plan capable in its ultimate development of furnishing a water supply to the 3½ to 4 million persons who, it was estimated, might "reside within an area of about 300 square miles," including the present city [then less than 100 square miles in area], at some time between 1950 and 1960.

The studies included a consideration of: (1) The density and character of the population to be supplied and its probable distribution over the area that it may occupy; (2) all possible sources of water supply; (3) the locations and capacities of the distributing centers and the tunnels connecting them with the source of supply; (4) the system of distribution and distributing mains to be employed in order to deliver the output of the several pumping stations to the consumers with a maximum of reliability and at satisfactory pressures.

It is with the last of the above-enumerated phases of the problem that this article deals. It is proposed by the writer to present briefly the principal features of a plan outlined by him in a report to George H. Fenkell, superintendent and general manager of the department of water supply, to distribute water to a metropolitan area.

Scope of the Project—By reference to the accompanying map, it may be noted that the area indicated is roughly triangular in shape with a hypotenuse about 30 miles in length bordering Lake St. Clair and the Detroit River and containing about 300 square miles. The ultimate plan, however, contemplates service to a much larger area, including Port Huron 50 miles to the northeast, Pontiac 25 miles to the northwest, Ypsilanti 30 miles to the west and Monroe nearly 40 miles to the southwest of Detroit, including in this greater metropolitan area about 1,800 square miles. The territory to be served is gently sloping from the river to the north and west, the maximum difference in elevation in the 300 square miles being about 150 ft., and in the 1,800 square miles about 400 ft.

The plan, as developed, contemplates the distribution of water within the 300 square miles from three principal distributing centers, for the most part by direct pressure, but to the more remote and higher areas through electric booster stations. At a later date, to provide for the 1,800 square miles, additional distributing centers, taking their supply from Lake Huron on the north and Lake Erie on the south, are possibilities. Although at present "it would be premature to do more than establish tentative locations" for these additional centers "until the trends of development are more clearly defined" (Report of George H. Fenkell, Sept. 15, 1923), the immediate plan has been so worked out as to fit in with the ultimate.

The Distributing Centers—Considering the confines of the district shown on the map, the present city is served from a single pumping station, located near the river opposite the head of Belle Isle. This station has a maximum filter plant capacity of 360 m.g.d. and a maximum pumping capacity of about 460 m.g.d. It delivers water into three pressure areas through twelve mains varying in size from 42 to 60 in. in diameter. Water is now delivered under direct pressure about 15 miles "as the crow flies." The maximum consumption last year was at the rate of about 390 m.g.d., and the average annual increase in the maximum rate expected in the immediate future is about 20 m.g.d. It thus appears that the city has only a few years to go before an additional supply must be in service if a shortage is not to be experienced.

In the west central portion of the area the map shows the location of the so-called Springwells station, now in process of design. This station is expected to have an ultimate maximum capacity of about 350 m.g.d. and will be fed by a 12-ft. gravity tunnel, now being built, reaching across the city to the east and connecting with a 15-ft. intake tunnel and intake at the upper end of Belle Isle. The Springwells station will consist of a low-lift plant, lifting the water 60 to 80 ft. to a filtration plant, whence it may be delivered to a large clear water reservoir and high-lift pumping plant.

In the north central portion of the area the map shows the proposed location of the third distributing center, called the northeast station, which, in a manner similar to the Springwells station, will draw its water from a 10-ft. gravity tunnel, filter the same and deliver, under the requisite pressures, a maximum of about 200 m.g.d.

Questions Considered—Some of the questions considered in connection with the studies were: (1) At what pressures and over what range of pressures should the several pumping plants operate, and what system of control over pressures may be devised to assure a uniform service? (2) It is feasible to serve the entire area as an

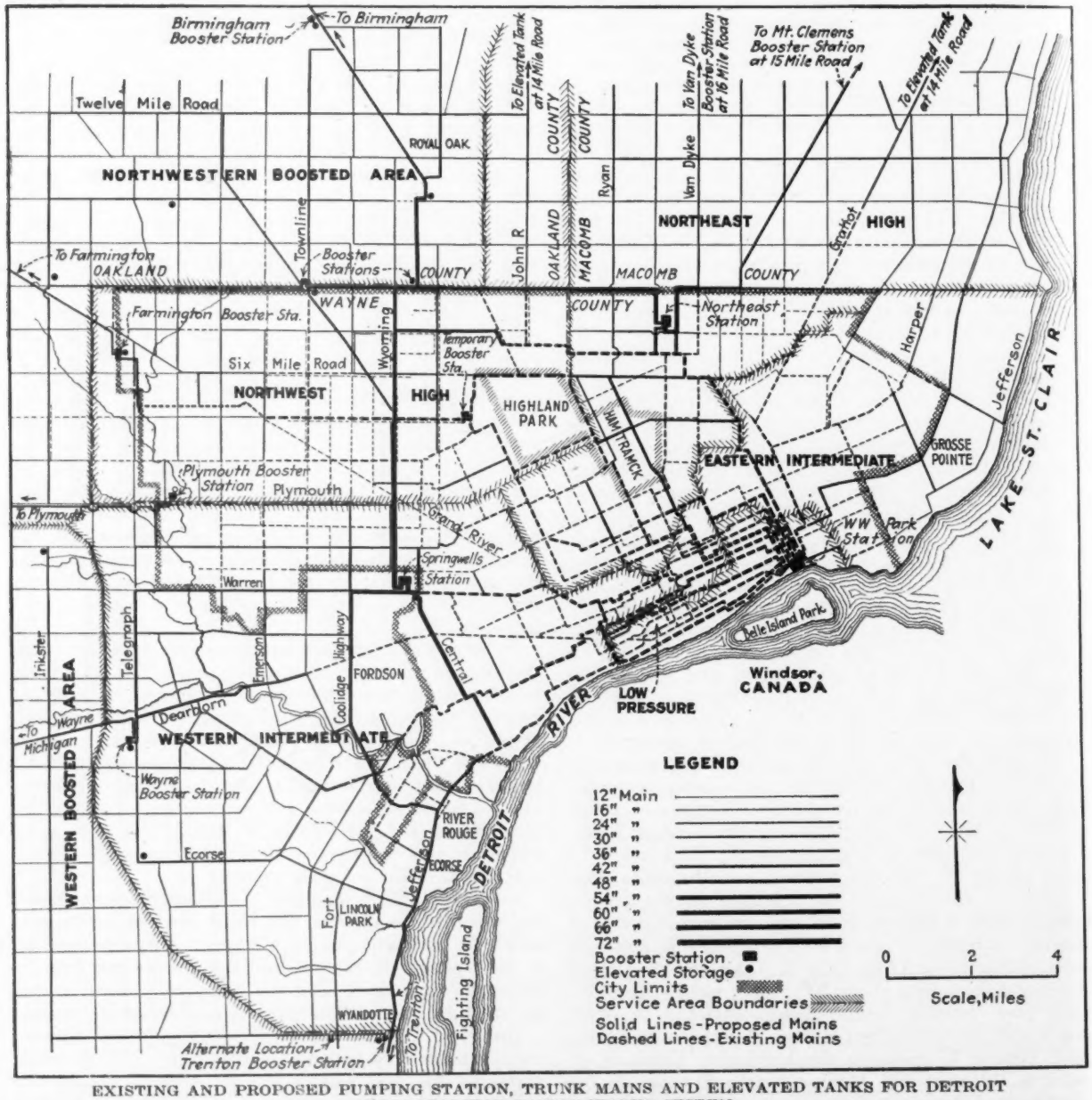
open system without any closed valves, or should the area be portioned to the several distributing centers; and if the latter, what are the proper lines of separation between service areas? (3) In each pumping plant is it feasible to deliver all water at the same pressure, or should there be separate services at different pressures; and if separate services, what quantities of water may be required of each service as the years go by? (4) What system of distributing mains will best serve to deliver the output of the several stations to their service areas? (5) What are the limits of direct service beyond which additional pumping will be required and where should the booster stations and elevated tanks be located to best serve the boosted areas?

Although it is impracticable to answer these questions serially, as presented, the following discussion will outline the conclusions reached. In arriving at the answers "cut and try" methods were used. An answer was assumed, applied to the facts, and, if found unworkable, abandoned. To a considerable extent the methods are applicable only to the specific problem, but there are certain general conclusions reached that are of more than local interest.

Some Assumptions—Two assumptions were made, as follows:

1. Reasonable losses due to friction in feeder mains for different rates of consumption were taken as follows:

Consumption during	Loss in Mains, Ratio to Average	Loss in Mains, Pounds Per Mile
Minimum hour	0.55	0.75
Minimum day	0.80	1.50
Average	1.00	2.25
Maximum day	1.30	3.75
Maximum hour	1.60	5.50



EXISTING AND PROPOSED PUMPING STATION, TRUNK MAINS AND ELEVATED TANKS FOR DETROIT METROPOLITAN WATER-WORKS SYSTEM

Present pumping station, at Water-Works Park, opposite Belle Isle, with additional pumping and booster stations to be constructed, will deliver water to seven service areas through 504 miles of 72- to 16-in. mains, the largest of which, as well as some of intermediate size, are of steel. Some 1.5-m.g. elevated steel tanks are under way and will probably be followed by 2-m.g. tanks.

2. About 50 lb. was assumed a satisfactory average main pressure for the central portion of the city and 25 for the outskirts during the hour of maximum consumption.

Regulation of Pressures—In the regulation of pressures over a service area three methods of operation may be considered. Pressures may be maintained uniform (a) at the pumps or (b) at the boundary of a service area or (c) at a point within the area, say midway between the pumps and the boundary. If the pressure be maintained uniform at the pumps, the fluctuations in pressure at points throughout the area served may be assumed to vary, due to change in the rate of consumption, in proportion to the distance from the pumps. Hence the most remote points will experience the greatest fluctuations. If, on the other hand, the pressure be maintained constant at the most remote point in a service area, then the maximum variation occurs at the pumping station.

An application of this to the service areas under consideration indicated that there would result variations in pressure of from 38 to 43 lb. in the service area boundaries if the pump pressures were kept constant, or in the pump pressures if the boundary pressures were kept constant. Obviously 40-lb. variation in distribution pressures, particularly if occurring in built-up residential districts, is excessive.

Further, the examination of preliminary characteristic curves of suitable large steam-turbine-driven centrifugal pumps indicated that although a range of 50 ft. or 20 lb. is permissible without materially affecting the unit efficiency, a larger variation, in units of the heads contemplated, is to be avoided.

With a loss per mile of main of 0.75 lb. during the minimum hour and 5.5 lb. during the maximum hour, or a range of 4.75 lb. per mile, it is possible to maintain a uniform pressure at a point 4.2 miles distant from the pumping station without having the variation at the pumps exceed 20 lb. As it happens, in Detroit 4.2 miles is not far from one-half the distance from any station to its extreme point of service. The obvious inference therefore was that if at convenient control points in the distribution system not more than 4 miles distant from the pumps pressures could be maintained uniform, then the pressures at the pumps and at the extreme points in the boundaries would fluctuate within reasonable limits, with the control points acting as fulcrums.

Single Open System Impossible—It was at first thought that to operate the entire metropolitan area as a single unit and without any closed valves in the distribution system would be an ideal arrangement for a comparatively flat area like Detroit. The physical conditions, however, make this impossible. As between stations, the ground surface at Springwells is about 14 lb. and that at the northeast station about 25 lb. above the zero of the water-works station gage. An open system and a single pressure at any one station therefore is not feasible in relation to the two other stations. A difference in elevation of as much as 90 ft. exists between the extremities of the area that must be served from a single center in the case of both the Springwells station and the northeast station. Such differences require a separation of services.

Plan Proposed—Neglecting a small area in the downtown business district served separately from the Water-Works Park station and at lower pressures because of the age and strength of the existing mains, the plan proposed contemplates three pressure areas served by three stations, each station having two pressures and each area being served *jointly* from two stations. For example, Water-Works Park and Springwells will serve jointly without many closed valves all of the area marked on the map "Eastern Intermediate" and "Western Intermediate," extending from Grosse Pointe on Lake St. Clair to Wyandotte on the lower Detroit River, and Water-Works Park will serve jointly with northeast station all of the area marked "Northeast High," and Springwells will serve jointly with northeast station all of the area marked "Northwest High."

To maintain the pressure proposed each station will have a control point for each pressure, which means two control points for each service area, or six all told. The pressures at these points will be held constant at from 42 to 57 lb., depending upon the service area and ground surface elevations at the points.

This regulation requires a range of station pressures (lb.) about as follows:

	Water-Works Park, El. 572		Springwells, El. 604		Northeast, El. 630	
	Int.	High	Low	High	Low	High
Consumption during						
Minimum hour	68	81	47	70	54	59
Minimum day	71	84	50	73	56	62
Average	74	87	54	76	59	66
Maximum day	80	93	60	82	63	74
Maximum hour	87	100	67	90	68	82

Having determined the definite boundary lines of the service areas and the division of these areas as between stations, the quantities of water that will eventually need to be delivered out of each station at each pressure was estimated by reference to previous studies on water consumption. From these data a system of distributing mains was laid out as shown by the map suitable for the distribution from three centers of a water supply for 3,750,000 persons.

The system of mains out of Water-Works Park is now complete and its share of the intermediate service will be served by five 48-in. mains having a total average daily capacity of 130 m.g.d. The portion of the water going from this station to the northeast high area will be delivered through one 42-, two 48- and one 60-in. mains, the latter steel and all the others of cast iron.

The Springwells station will deliver its share of the intermediate service into one 66-in. steel main to the west and one 72-in. steel main to the east (which latter branches shortly into one 36-in. cast-iron main to the north and one 66-in. steel main to the south) and an existing 42-in. cast-iron main to the east, and its share of the northwest high service into a single 72-in. steel main to the north.

The northeast station will deliver its share of the northeast high service through a 30-in. cast-iron main to the west and a 66-in. steel main to the east, and its share of the northwest high service through an existing 48-in. cast-iron main and a 54-in. steel main to the west.

The foregoing brief statements regarding the principal feeder mains are given to emphasize two points: A few mains of large size are contemplated in place of a larger number of smaller size, and steel is proposed in lieu of cast iron. A consideration of the reasons for using large sizes is beyond the scope of this article. Obviously, the quantities of water to be handled are large and the physical difficulties involved in finding a place to lay, for example, six 36-in. mains having the same capacity as one 72-in. main were an important factor. The use of steel in lieu of cast iron, for mains more than about 36 in. in diameter, is proposed with the idea of avoiding in the future some of the serious breaks in

large cast-iron mains that have been experienced in Detroit in the past. As a part of the plan the outlets at the pumping plants will be so designed that any large steel main, if and when necessary, can be duplicated and the service transferred to the new main without serious inconvenience or interruption of the supply.

The mains shown on the map, 16 in. and more in diameter, have a length of about 504 miles and will have cost when complete about $38,600,000.

Boosted Pressure Areas—The areas beyond the reach of direct pressure, including the immediately outlying towns, may be served Detroit water as rapidly as they desire through booster stations containing motor-operated centrifugal pumps of suitable capacities and pressures. At or near the suction sides of the pumps sufficient storage will be provided to prevent the pumping action of the booster station reducing the pressures within the direct pressure area to a point too low for satisfactory service. In the boosted areas elevated storage tanks are planned at the high points, at the ends of mains or in the small centers of population. It is the plan to operate the booster stations with automatic equipment and also to install units of such size as will permit economic grouping to meet the water demands of the area, as these may vary from time to time.

To protect the tanks from overflow, or from emptying in case of a main break, altitude valves are being installed. In some instances clock-controlled devices may be used so that the contents of the tank may be discharged into the mains only when most needed.

In a boosted pressure area the chief functions of elevated storage are to afford a reserve supply in the event of failure of electric energy and to permit of more efficient operation of the booster pumps. Too much emphasis, however, can hardly be given to the value of elevated storage in the outskirts of direct service in relieving the peak load on the main pumping station during the maximum hour. Arthur Morrill has pointed out (*Journal* A.W.W.A., November, 1926, p. 590) that "only 1.6 per cent of an annual average day's pumpage" in elevated storage will reduce the ratio of maximum hour to average, under Detroit conditions, from 1.80 to 1.60 or "by more than 10 per cent."

The tanks thus far installed have a capacity of 1.5 m.g. contained between two horizontal planes 50 and 100 ft., respectively, above the ground surface at the site. A capacity of 2 m.g. is being considered for future tanks.

Louisville Adds Pumps and Filters

Material enlargements to the raw-water and filtered-water pumpin stations and to the filtration plant of the Louisville water-works are well on towards completion. At the Ohio River pumping station, a 40-m.g.d. turbo-centrifugal pump has been added and an electrically driven 60-m.g.d. centrifugal pump is being installed, bringing the total capacity up to 170 m.g.d. At the Crescent Hill high-lift pumping station, for pumping filtered water to the city, a new 40-m.g.d. turbo-centrifugal pump has been provided, giving a total capacity of 152 m.g.d., and two boilers, with a combined capacity of 1,000 hp.; have been added. A new filter house has been built, with filters having a rated capacity of 48 m.g.d., supplementing the old 72-m.g.d. filters. All this work has been done under the direction of Alvord, Burdick & Howson, Chicago, consulting engineers for the Louisville Water Company, of which John Chambers is engineer and superintendent.

New Pumping and Water-Treatment Works for New Orleans

IMPORTANT enlargements of the water-purification plant at New Orleans, La., and increased low-lift pumping capacity are being carried out by the Sewerage and Water Board in order to keep well ahead of requirements in the city's water source. At present the distribution system of 718 miles reaches about 98 per cent of the population, and the pump and filter capacity are sufficient.

The new purification works, now 75 per cent completed, will include two grit and two chemical mixing reservoirs, four coagulating reservoirs and eighteen filter units of 4-m.g.d. capacity, or 72 m.g.d. in all. This new plant, adjacent to and cross-connected with the original 40-m.g.d. plant of 1909, will be capable of independent operation, so that the original plant can be put out of service for overhauling, after which the two plants can be operated either independently or in combination. The plant as a whole will then have a nominal capacity of 112 m.g.d. and an overload capacity of 168 m.g.d, which is considered adequate for at least fifteen years.

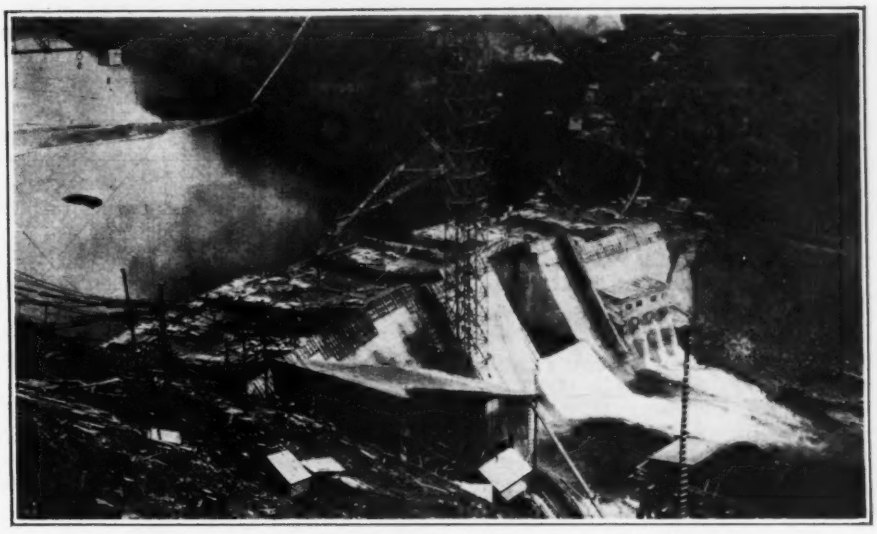
To supply sufficient water for the purification works, an electrically operated low-lift pumping station is being built just inside of the river levee, so that the length of suction pipe will be reduced to a minimum and the capacity of the two 4,000-ft. 48-in. pipe lines to the purification plant will be brought up to the required amount. There will be three large centrifugal pumps driven by a combination of six synchronous motors so coupled and arranged that pump speeds can be varied to work economically through the wide range of quantity and lift which results from a 20-ft. variation in the river level and a wide variation in the rate of pumping, and therefore in the friction loss in the 48-in. pipe lines. As power for these pumps and for the pumps of the sewerage and storm-water drainage systems is generated at the water-works pumping station, the four 600-hp. boilers installed in 1908 are being replaced with three boilers of 4,000-hp. each, equipped to operate with powdered coal, oil or gas. These, with 3,600 hp. of oil-burning boilers installed a few years ago, will give a total boiler capacity of about 16,000 hp. to serve two existing turbo-generators each of 6,000-kw. capacity, and an additional generator of 12,000-kw. capacity to be installed at an early date, besides the steam-driven high- and low-lift pumps. This power station supplies current to operate eleven sewage pumping stations and six storm-water drainage pumping stations, as well as the water-works pumping station on the opposite side of the river and the new low-lift pumping station previously mentioned.

At an election on April 17 the Sewerage and Water Board was authorized to issue $9,000,000 of additional bonds during the next three years, which with its ordinary surplus will give it $14,700,000 for construction during that period. The major expenditures will be for the necessary increases in power, pumping and canal capacity for the storm-water drainage system, but there will also be extensive outlays for additional sewage pumping stations and increased capacity of some of the old ones as well as for main sewer collecting lines to reach new areas and for local sewers and house connections. The $14,700,000 will provide also for the water-works improvements outlined in this article and for considerable strengthening and extension of the water-distribution system. George G. Earl is superintendent of the New Orleans Sewerage and Water Board.

Water Supply and Distribution at Portland, Ore.

Source, Gravity Lines, Distribution Districts and Variations in Peak Demands Between Business and Residence Districts

By Ben S. Morrow
Engineer, Bureau of Water-Works, Portland, Ore.



CONSTRUCTION VIEW OF BULL RUN DAM FOR PORTLAND, ORE.
Concrete structure to form impounding reservoir. View taken May 2, 1928

PORTLAND, ORE., obtains its water supply from the Bull Run River at a point 25 miles east of the city. The entire 102 square miles of watershed is located within the Bull Run Forest Reserve, a heavily timbered, uninhabited area of 218 square miles, set aside in 1892 by President Harrison for the water supply of Portland. Trespassing and grazing of stock on the preserve are prohibited by act of Congress.

The Bull Run River at the point of diversion has an average flow of 500 m.g.d., but, as is true of all streams of the western Cascades, this flow is subject to wide seasonal variations. The maximum flood reaches 21,000 sec.-ft. and the minimum, which occurs in the summer at the time of heavy demand for supply, is as low as 64 sec.-ft., or 41 m.g.d. Bull Run Lake has heretofore been used for storage and the city now has a second storage project under construction. Bull Run dam is of gravity section, 200 ft. high, curved in plan to a 600-ft. radius. The crest length is 950 ft. and the dam will contain 230,000 cu.yd. of concrete. (See *Engineering News-Record*, May 26, 1927, p. 842.) The total impoundage is approximately 11,000 m.g., sufficient to insure a minimum supply of 185 m.g.d. to the city.

From the headworks on the Bull Run River, at El. 750, the water is conveyed to the city through three steel conduits, with capacities as follows: No. 1, 25 m.g.d.; No. 2, 50; No. 3, 74 m.g.d. Water is delivered in the city at the two Mount Tabor high-gravity reservoirs at El. 411.6. Although the system supplies water to El. 1,096, only 4 per cent of the water delivered is pumped.

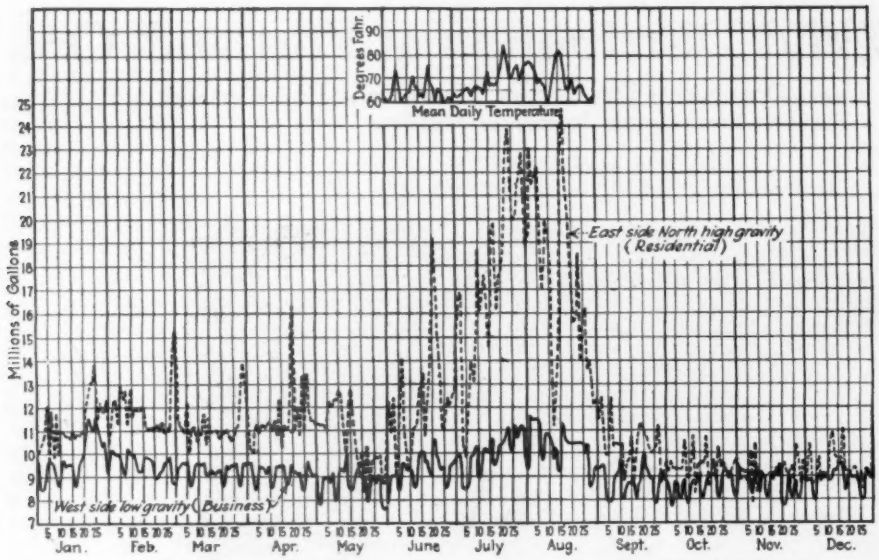
Portland covers an area of 66 square miles. It is located on both sides of the Willamette River, with the main business section on the west side. Water is delivered to the distribution reservoirs in this area from the Mount Tabor reservoirs through a 32-in. cast-iron main, the river crossing being 24- and 30-in. submerged pipes.

The distribution system of the city consists of more than 1,100 miles of mains, 800 of which are 4- to 32-in. cast-iron pipe. The city population of 361,000 is supplied through 83,842 services, all metered. The meter rates are per 100 cu.ft. and are 9½c. for the first 20,000 cu.ft. and 7½c. for all over that amount. The average daily per capita consumption for 1927 was 97.5 gal.

Portland, like most of the Western cities, is particularly a city of home owners. The climate is such that flowers and shrubs grow in great profusion, and as a result practically every residence is surrounded by well-kept lawns and has extensive plantings of shrubs and flowers. As these flowers and shrubs are at their best during the summer season, the demand on the distribution system for irrigation water in the residential section is the main factor during that time of the year.

A comparison of the seasonal and daily demand on the distribution system in typical business and residential sections of the city may be of interest to water-works men as affecting the design of distribution systems in cities of this character. The west side low-gravity system supplies mainly a business district and has a total of 6,598 services. As shown on the accompanying chart, this section is subject to only slight seasonal variations in demand. The daily average consumption for the year is 9.24 m.g. and the maximum demand, occurring during a period of cold weather in January, is 11.62 m.g., or only 25 per cent in excess of the average daily demand for the year. This excess was occasioned by letting faucets run continuously to avoid freezing. The hourly variation is not at all comparable with other sections of the city.

In contrast, the east side north high-gravity system supplies a purely residential section, with 30,646 services.



DAILY WATER-CONSUMPTION CURVES FOR TYPICAL BUSINESS DISTRICTS, PORTLAND, ORE.

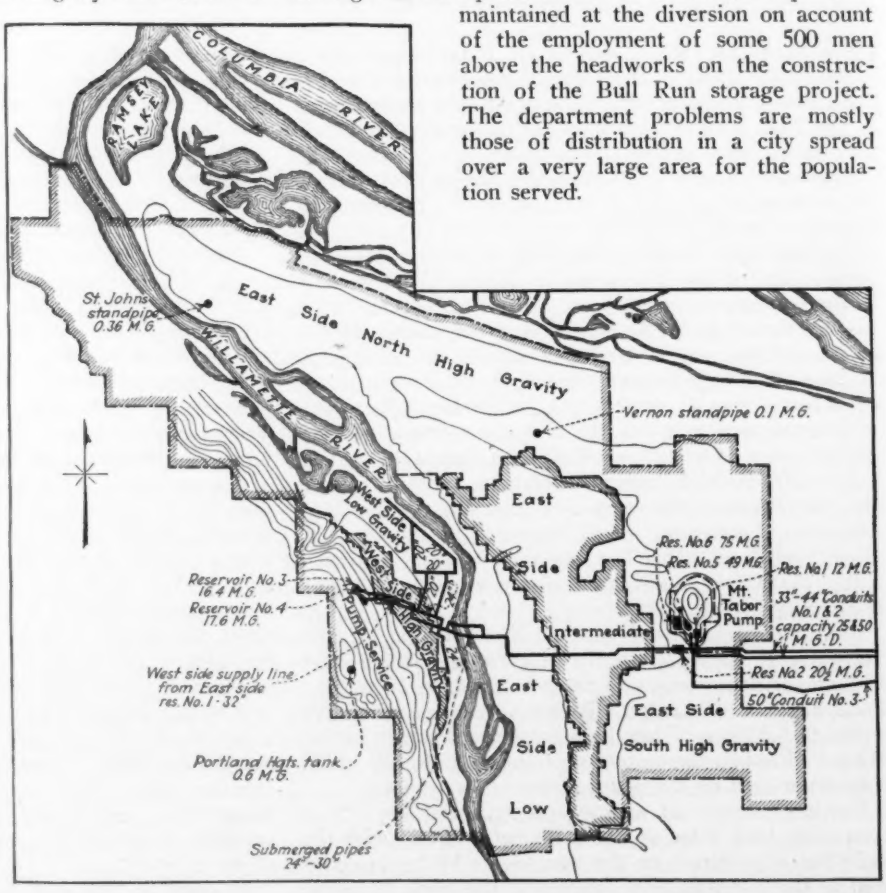
The daily average consumption for the year is 11.991 m.g.; the maximum daily demand (Aug. 17) 24.724 m.g. The demand in this district was subject to extreme hourly variations on this day, the maximum rate being reached at 8 p.m., when the system was called upon to deliver water to this area at the rate of slightly more than 48 m.g.d., which is four times the yearly daily average rate and twice the rate of demand for the maximum day. A comparison of the rate of demand in other residential sections of the city bears out this relation and it has given us a handy rule of thumb for estimating the requirements in various portions of the distribution system.

As the chart shows, the summer draft on the system follows very closely the variations in temperature. The mean precipitation for July and August is 0.62 in. per month. The corresponding mean temperatures are 67.2 and 66.8 deg. F. Any summer extremes of temperature usually occur for only three-day periods, which are followed by several days of relatively cool weather.

The east side north high-gravity district is supplied from reservoirs Nos. 1 and 5, at Mount Tabor, through three lines, 40, 30 and 24 in. in diameter. These reservoirs are located at the extreme southern end of the district, which is 9 miles in length. In order that the supply lines might not be called upon to carry the extreme peak demand, a 1-m.g. elevated tank was constructed near the center of the area, and a 0.365-m.g. standpipe was erected at the northerly end of the district. During the summer the tank and standpipe are operated to discharge during the peak demand, and for three hours of the evening sprinkling period furnish about 25 per cent of the water required. Satisfactory pressures within the system are maintained even during the time of heaviest draft.

In the layout of the distribution system it has been the policy of the department to use 8-in. cast-iron pipe in the grid system in the residential sections and 12-in. pipe or larger in the high-value district, with trunk reinforcements as required to give the necessary supply.

Portland is unusually fortunate in having an ample supply of very pure mountain water from a source not subject to pollution. Normally no treatment is required, although at the present time a chlorination plant is maintained at the diversion on account of the employment of some 500 men above the headworks on the construction of the Bull Run storage project. The department problems are mostly those of distribution in a city spread over a very large area for the population served.


COLUMBIA RIVER
RAMEY LAKE
St. Johns standpipe 0.36 M.G.
WILLAMETTE RIVER
East Side North High Gravity
Vernon standpipe 0.1 M.G.
West Side Low Gravity
West Side High Gravity
Pump Service
Reservoir No. 3 16.4 M.G.
Reservoir No. 4 17.6 M.G.
West side supply line from East side res. No. 1 - 32"
Portland Hgts. tank 0.6 M.G.
Submerged pipes 24"-30"
East Side Intermediate
East Side High Gravity
East Side South High Gravity
East Side Low
Res. No. 6 7.5 M.G.
Res. No. 5 4.9 M.G.
Res. No. 1 12 M.G.
Mt. Tabor Pump
33"-44" Conduits No. 1 & 2 capacity 25 & 50 M.G.D.
Res. No. 2 20½ M.G.
50" Conduit No. 3

LAYOUT OF WATER-DISTRIBUTION SYSTEM AND VARIOUS PRESSURE DISTRICTS, PORTLAND, ORE.

Experimental Water-Filtration Plant for Chicago

City Builds $150,000 Plant to Determine Most Efficient and Economical Plan of Coagulation, Sedimentation, Filtration, Carbonation and Chlorination of Billion Gallons Daily

By Loran D. Gayton
City Engineer of Chicago

Largest of the Cities on the Great Lakes and the only one except Milwaukee without a water-filtration plant, Chicago has become convinced of the need of filtering its water supply, which already averages 875 m.g.d. and will soon expand to a billion gallons. Desirous of ascertaining the most efficient method of treating and mindful of the savings in capital and operating cost that would be effected by adopting the most economical method of treatment, it has built an elaborate testing plant in which a variety of experiments will be made to determine what plan of treatment will best meet its local conditions.

—Editor.

ALL the large cities on the Great Lakes either have resorted to filtration of their water supplies or have found that they must do so eventually. Chicago is no exception. Its department of public works has recently put into use a rather elaborate experimental filtration plant, built at a cost of about $150,000. It is a complete plant on a small scale, designed and equipped to enable almost any conceivable studies of water treatment to be made, all with a view to determining the most efficient and economical method of purifying the entire water supply of Chicago, now drawn from Lake Michigan at the rate of 875 m.g.d. and treated by chlorination only.

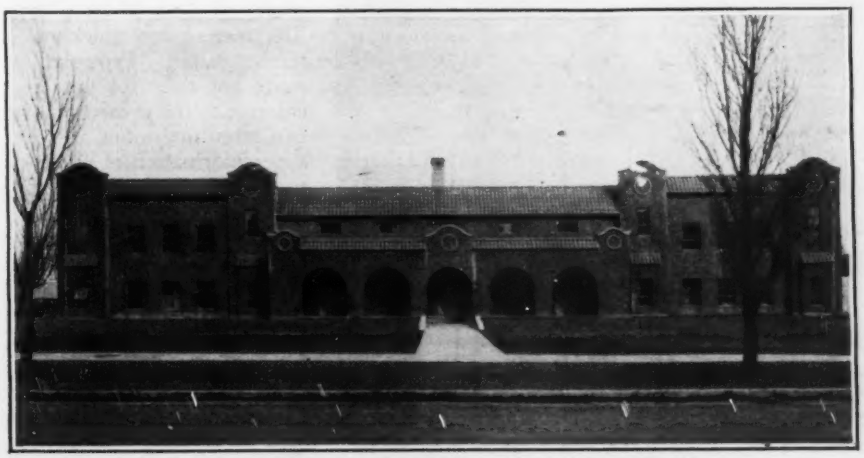
The experimental plant is located at 69th St. and Oglesby Ave., adjacent to the 68th St. pumping station, and treats water from the Edward F. Dunne crib, some 4 miles off shore. Water is pumped to a raw-water equalizing tank and flows thence to chemical mixing basins, coagulating and settling basins, twelve mechanical filters with a total capacity of 0.75 m.g.d. and finally to a clear well beneath the filters. The supply is under automatic control throughout. There are four chemical solution tanks equipped with orifice feed devices and three types of mixing chambers. Various periods of detention in the coagulating and settling basins and various rates of filtration are being tested. Carbonation and chlorination are also being studied. Chemical and bacterial laboratories are provided. The entire plant, except the chemical laboratory, is housed in a wood frame and stucco building, of Spanish mission type, 53x133 ft. in plan and 35 ft. high.

Water Supply—Two motor-driven centrifugal pumps with automatic switch control deliver water to a 5,000-gal. raw-water tank, which supplies the mixing basins. Chlorinated water from the discharge mains of the 68th St. pumping station, under 50-lb. pressure, is used for operating valves, motors, fire-protection, mixing chemicals and other plant purposes. This water is also available for test purposes.

Chemical Feed—There are four chemical solution tanks, of wood staves, and one dry-feed device, the whole piped to feed three different chemicals at one time, as is necessary in some of the tests. Two of the tanks are used for lime and two for alum, iron and soda ash. Orifice feed tanks are provided.

Mixing Basins—Three types of chemical mixing basins are provided: around-the-end, over-and-under and mechanical agitator. These are all of wood, set in a concrete basin to prevent leaks. The agitator basin is in eight compartments, each equipped with revolving paddles, with driving mechanism in two units, each a 1-hp. electric motor of 900 r.p.m., reduced to 15 r.p.m. by spur-gear, with provision for further reductions down to 5 r.p.m. Water enters at the bottom of the first compartments and rises as it is agitated. The process is repeated in as many basins as are needed to give the required mix. Taps or take-offs are provided at fixed points in all the mixing basins so that the mixing actions at various points can be tested and so that the mixed water may be drawn off and conveyed to other equipment for special treatment.

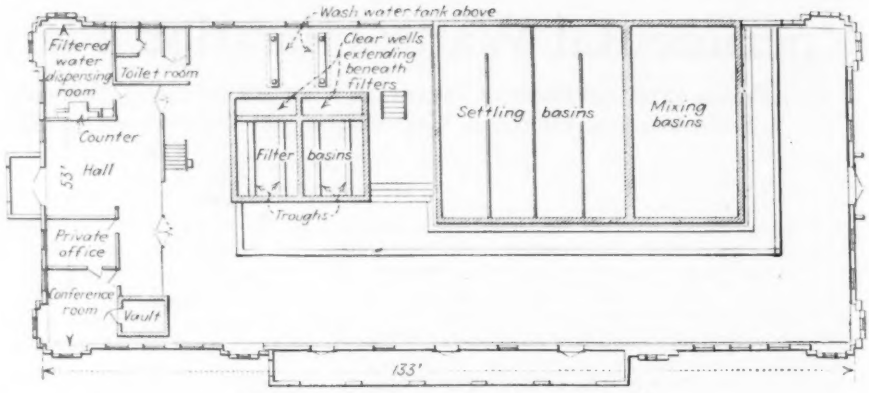
Coagulating and Settling Basins—A concrete tank 30 ft. wide, 31 ft. long and 12 ft. deep at its lowest level is divided into four basins. This permits two parallel treatments, using two basins for each. Usually water passes through one basin and out through another in an opposite direction. Troughs deliver the mixed water to the surface of a basin, from which it goes to the bottom, then rises and flows over an adjustable weir to the next basin. The settled water is taken off at the surface and conveyed to the filters.



VIEW OF CHICAGO EXPERIMENTAL FILTER PLANT

Filters—Of the twelve filters, two are large, with concrete walls, and with clear well beneath, and ten are cylindrical steel tanks, mounted on platforms, and are readily movable to any point demanded by the tests. The larger filters have areas of 100 sq.ft. and capacities of 0.25 m.g.d. each, and the

smaller ones 10-ft. areas and capacities of about 0.03 m.g.d. Each of the twelve filter tanks is 9 ft. deep, equipped with cast-iron manifolds and perforated laterals for underdrains, and contains 18 in. of gravel in five sizes ($\frac{1}{8}$ to 2-in.) and 27 in. of sand. For design purposes the rate of filtration assumed was 125 m.g.d., or 2 gal. per square foot per minute, but rates up to double these are proposed. Upward wash at 15 gal. per square foot per minute is provided for; also surface wash, through a pipe manifold immediately above the sand surface. Of the two large filters, one is equipped with hydraulic-operated and the other with hand-operated valves. Each has loss-of-head and rate-of-flow registering and recorded gages, mounted on a table. Each of the ten small portable filters will be provided with a Venturi meter on the effluent line. The rate of filtration will be controlled by hand, but if this proves to be unsatisfactory, rate controllers will be used. The object of the small filters is to cover a wide range of rate variation in a short time. The same water will go to all the filters, only the rate being varied, and the same hydraulic conditions will govern both the small and the large filters.



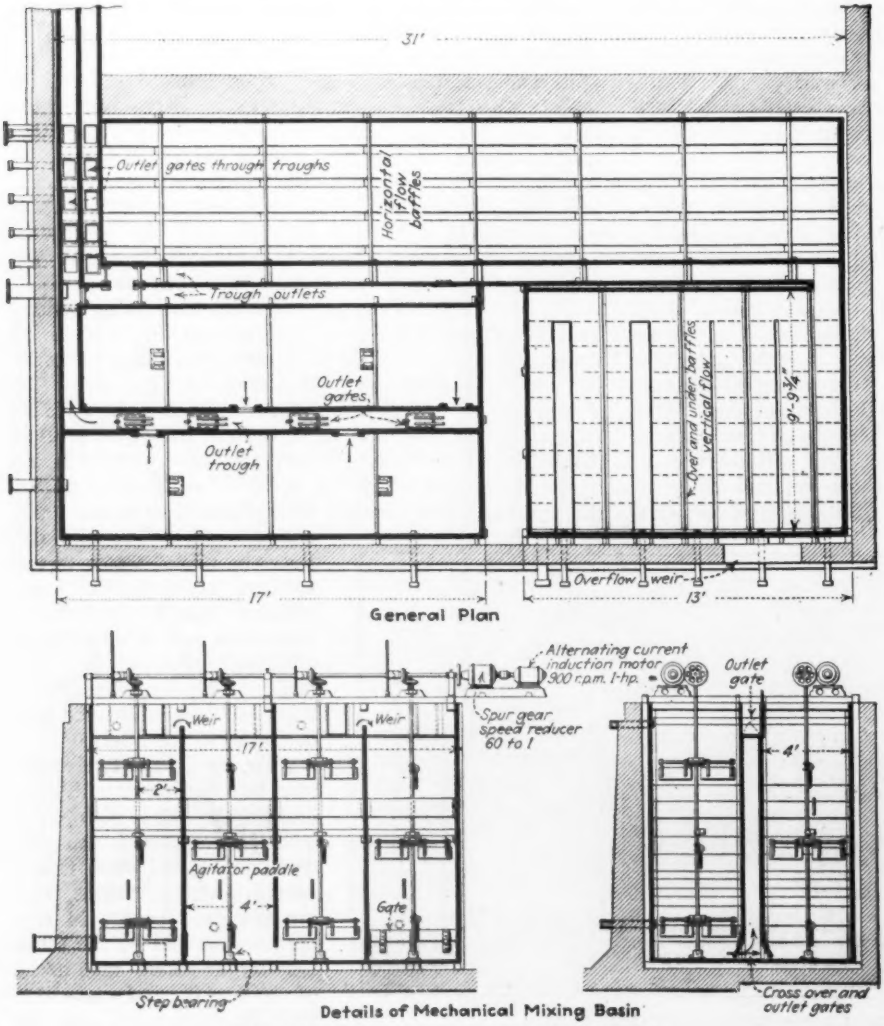
FIRST-FLOOR PLAN OF FILTER BUILDING

Wash water will be pumped from one of the 5,000-gal. clear wells to a 5,000-gal. tank, set about 12 ft. above the wash-water troughs. Each of the two wash-water pumps is motor-driven and automatically controlled.

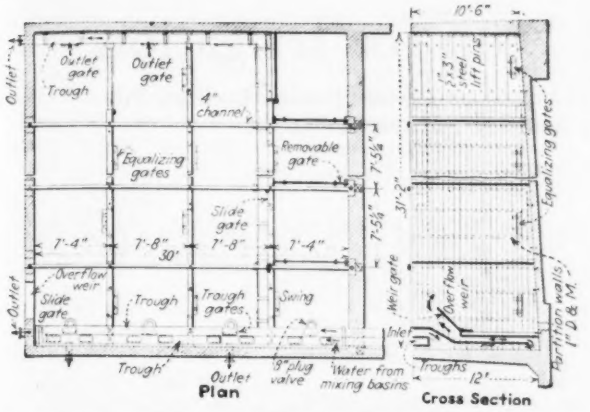
Carbonation—Extensive carbonation experiments with a view to neutralizing the excess alkali from lime treatment are proposed. City gas will be passed through a burner, coke scrubber and compressor and delivered through a pipe manifold diffuser located at a depth of 10 ft. in the settling basin to be treated. A CO_2 recorder is provided.

Chlorination—Two manual-control solution feed chlorinators of a new type, which applies the vacuum principles to machines of low capacity, have been installed. Each machine is equipped with two meters, one of the bubbling type, with a daily capacity of 0.1 to 1 lb. of chlorine, and one with a capacity of 1 to 10 lb. a day. The meters are quickly interchangeable. Provision is made not only for applying chlorine to the effluent of the two large filters but also for superchlorination at the inlet to settling and coagulating basins.

Laboratories—The chemical laboratory is located in the 68th St. pumping station, close by, and the bacterial laboratory on the second floor of the filter building. Small sand filters in the chemical laboratory will be used as tryouts, thus saving time at the main experiment station.



PLAN AND SECTION OF MIXING CHAMBER



CHEMICAL MIXING CHAMBERS AT EXPERIMENTAL PLANT
Three types are used: Around-the-end and over-and-under baffles and mechanical agitation. The walls are of wood, set in a concrete basin.

Range of Experiments—Experiments already made [small-scale tests have been going on for a year or more —EDITOR] indicate that Lake Michigan water is not difficult to clarify, but that there will be considerable trouble with micro-organisms, this also being the experience at all cities on the Great Lakes. The question is not whether the water can be treated successfully, but how this particular water at Chicago can be best and least expensively treated. Little is known as to comparative efficiency and cost of possible available methods. One treatment may be more effective than another in removing certain kinds of pollution now going into the lake. While it is hoped and expected that much of this pollution will be eliminated, or at least that it will be greatly decreased in the near future, enough will probably remain to warrant operating filters at their maximum efficiency.

Dispensing Filtered Water to Public—A dispensing room has been provided at the experimental plant from which filtered water in small quantities will be supplied to the public. For the present the public may help itself to water from faucets. Later, service will be given. There are also facilities for the exchange of bottles and for cleaning and sterilizing them.

A drinking fountain is supplied with water cooled by electric refrigeration, which also serves an icebox and two incubators in the bacterial laboratory. Two sight glasses constructed like aquariums, equipped with electric light reflectors, are used to display to the public the raw water and filtered water side by side.

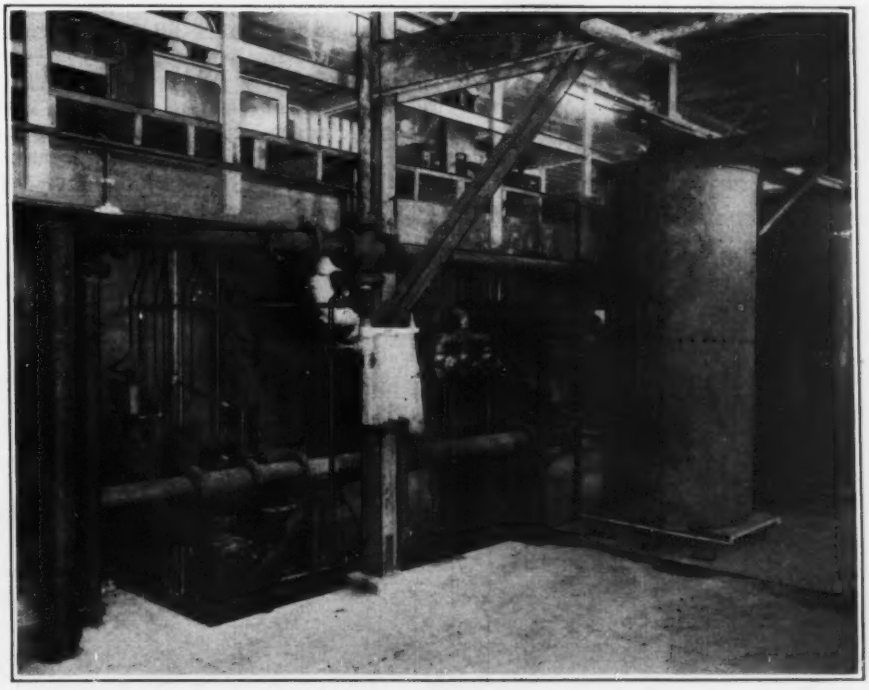
Personnel—The design, construction and operation of everything connected with the Chicago water-works is under the direction of Richard W. Wolfe, commissioner of public works. John R. Baylis, who was formerly with the Baltimore Water Department, is in charge of the operation of the experimental filtration plant. The plant was designed by Alfred H. Marshall, of the bureau of engineering, working with Mr. Baylis, under the general direction of the writer.

Greater Vancouver Water District

The Greater Vancouver Water District includes Vancouver, B. C., and the six adjacent municipalities of South Vancouver, West Vancouver, North Vancouver, Point Grey, Burnaby and Richmond, with a population of 275,000. Consumption for 1927 was 10,377 m.g. The administrative board is composed of representatives from each member municipality of the district, appointed by the respective municipal councils. The chief executive is a commissioner appointed by the board.

Water supply is by gravity from two independent sources, on Capilano Creek and Seymour Creek, both regulated by mountain lake reservoirs. The drainage areas of these streams are held under 999 years' lease. There is no habitation on the Seymour Creek drainage area above the intake, but the Capilano Creek drainage area has small logging operations employing about 200 men. Sanitary regulations are stringently enforced. The value of the supply system is $6,500,000. No filtration or other treatment is necessary. Water is carried across Burrard Inlet in 18-in. submerged pipes, but the present problem is to get a more satisfactory crossing. A tunnel is suggested for the Capilano system and pipe lines through dam and locks for the Seymour system.

Water supply is metered in bulk to the various municipalities and is distributed by them. The Point Grey distribution is 100 per cent metered. Vaucouver and other municipalities meter all large consumers, amounting to about 15 per cent of total consumption. The cost of water in bulk is about 4½c. per 1,000 gal. The chief commissioner is E. A. Cleveland; engineer, W. H. Powell.



FRONT VIEW OF LARGE AND SMALL FILTERS AT CHICAGO EXPERIMENT PLANT
The two stationary concrete filters are at the left, in the rear. Two of the portable steel filters show at the right. The operating tables for one of the large filters may be seen in the gallery.

Earth and Rock-Fill Dam for Irrigation

Pleasant Valley Dam, in Utah, Has Earth-Fill Upstream Portion Backed by Rock Fill—Puddle Cutoff Wall—Gates in Spillway and Outlet Tunnel

By C. J. Ullrich
McGonagle & Ullrich, Salt Lake City, Utah

THE FOLLOWING ARTICLE was written before the leak in the Pleasant Valley dam was discovered on May 21. The recent developments in regard to the situation at the dame are given in the news pages of this issue. —EDITOR.

THE Pleasant Valley dam for irrigation service in Utah, completed in 1927, takes the place (but on a new location) of the Mammoth dam, on a branch of the Price River, which failed in 1917 as a result of faulty construction and caused damage which was estimated at $700,000, as described in *Engineering News-Record*, July 5, 12 and 26, 1917, pages 42, 52 and 189. The water rights and property were later acquired by a company which, with other water users, organized the Price River Water Conservation District, under the state laws. This district comprises about 37,000 acres. It was proposed originally to rebuild the Mammoth dam, but in view of the desire for a larger reservoir a new location was adopted in Pleasant Valley, on Fish Creek, which is one of two streams forming the Price River. The construction of this dam is shown in Fig. 1.

This creek has a drainage area of 167 square miles, at 7,600 to 12,000 ft. above sea level and with an average annual precipitation of 26 in. Its average annual runoff is about 63,000 acre-ft., and the dam was designed for an impounding capacity of 61,000 acre-ft. The site consisted mainly of meadow lands and includes 2,483 acres at maximum water level, El. 7,610; the capacity at this elevation is 61,250 acre-ft. The Pleasant Valley fault, one of the major geological faults in that part of the country, with more than 1,000 ft. displacement, traverses the site from north to south, but the engineers considered that the soil overburden was of sufficient depth to seal the reservoir against any appreciable underground leakage. Storage of water during 1927 proved this to be correct. As the Scofield branch of the Denver & Rio Grande Western Railroad passed through the site, it had to be relocated at higher elevation around the east side of the reservoir. General plans of the reservoir and the dam are given in Fig. 2.

Dam Design and Construction—This dam is of the earth and rock-fill type (Figs. 1 and 3), with a maximum height of 63 ft. above streambed and 78 ft. above bedrock. The rear portion is a rock fill with a downstream slope of 1 on 1½, while that of the upper side is 1 on ¾. Against this slope is placed the earth fill, the upstream side of which has a slope of 1 on 3 paved with 12 in. of rock riprap. The top width is 20 ft., including 6 ft. for the rock fill and 14 ft. for the earth fill. There is no roadway along the top.

The steep upper slope of the rock fill is faced with large rock laid by hand and by derrick, forming an inclined wall which tapers from 6 ft. thick at the base to 2 ft. at the top. The body of this fill was formed by dumping rock from trestles. It was intended originally to excavate the entire base of the rock fill to bedrock, but this would have increased the cost beyond the funds available. It was decided therefore to place the rock fill on the natural surface and to carry the rock wall down to bedrock for its full width of 6 ft. across the entire site, connecting it with a French drain 8 ft. wide extending to bedrock and down the creek bed to below the lower toe of the dam. Thus the rock wall would act as a drain intercepting any seepage water that might find its way through the earth fill or the upper half of the dam foundation, and the drain in the creek bed would carry off this water, thus preventing the earth foundation of the rock fill from becoming saturated so as to cause undue settlement.

Rock for the fill was quarried from the sandstone ledge forming the north abutment and extending 60 ft. above the top of the dam. The quarried rock was loaded with a steam shovel onto dump cars and hauled to place by light locomotives. Rocks up to 5 and 6 tons in weight were placed. This fill was carried up in three lifts. On the first lift all quarry waste and fine material was eliminated. For the two remaining lifts, the quarry-run material was used, but in this the fines, ranging from sand to 3-in. size, did not exceed 18 per cent in volume of the rock fill. The earth-fill portion was built up in 6-in. layers, each compacted with a 10-ton road roller and then harrowed before the next layer was placed. This material, obtained about 2,000 ft. upstream, was disintegrated sandstone and shale, which was highly impervious when compacted.

Adjoining the rock wall, a puddle core trench was car-

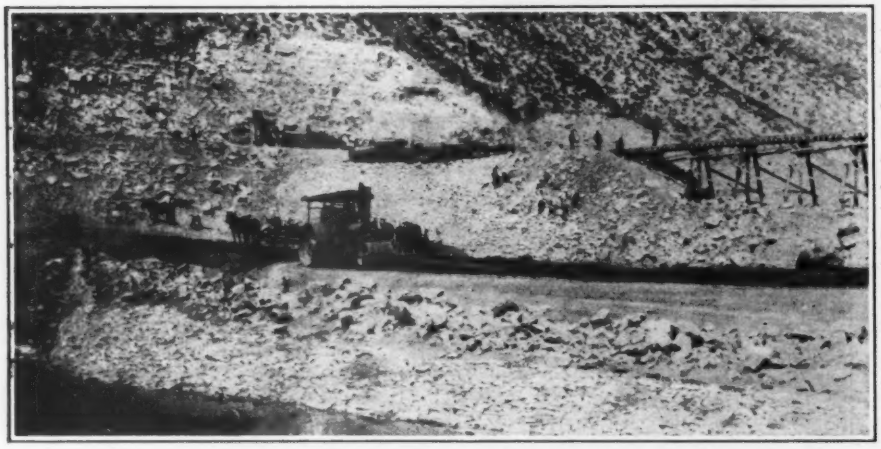


FIG. 1—BUILDING PLEASANT VALLEY DAM
Roller and graders placing earth fill, with riprap on upstream slope. Steam shovel, dump-car train and trestle for rock fill rear of dam. Men are facing this fill with large rock, against which the earth fill is placed.

ried from the ground surface down to bedrock across the entire dam site, and was filled with selected material puddled into place. This is shown in Figs. 3 and 4 prevent the puddled material from filtering into the rock wall, all interstices in the wall were chinked and closed. Considerable seepage water was encountered in excavating the trench, which necessitated placing the puddle core in sections.

Outlet Tunnel and Gates—In driving the outlet tunnel (Fig. 5) through the sandstone around the south end of the dam, the contractor experienced difficulty in keeping down the overbreakage, as the formation was fissured and broken. Above the gate chamber the tunnel is 6 ft. square, while below the chamber it is 2 ft. wider in order to accommodate the gates, which had to be transported through the tunnel. The gate chamber is an enlargement in the tunnel from 6 to 12 ft. in width. Here a water-

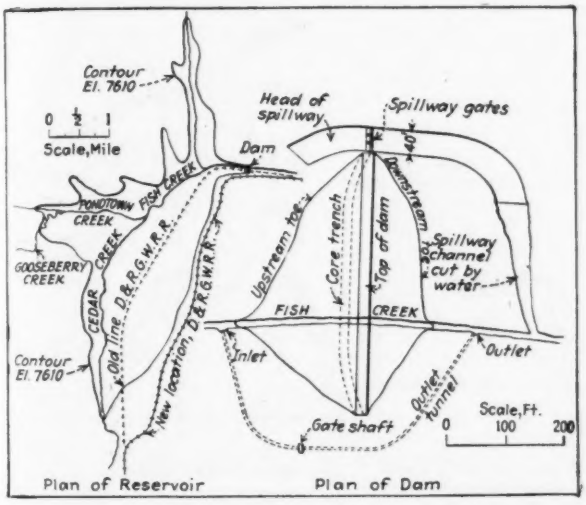


FIG. 2—IRRIGATION RESERVOIR AND DAM

tight concrete bulkhead was built, into which were set two 48-in. cast-iron wall thimbles, to which were bolted two 48-in. pivoted disk valves. A vertical shaft, 4x7 ft., leads from the gate chamber to the surface of the ground, the gate stems passing up this shaft to the gate house. Each valve is equipped with hoisting mechanism of such gear ratio that one man can operate the gate against the maximum head of water. Each gate valve has a rated free-flow discharge capacity of 506 sec.-ft. under maximum working head.

A spillway 40 ft. wide, cut through the sandstone ledge forming the north abutment, constituted a part of the quarry and has its floor 15 ft. below the top of the dam. Provision was made for 5 ft. of stop logs in the spillway, giving the dam a minimum freeboard of 10 ft. At its lower end the spillway terminates on the hillside, allowing the water to cut its own channel back to the creek (see Fig. 2). The capacity of the spillway is

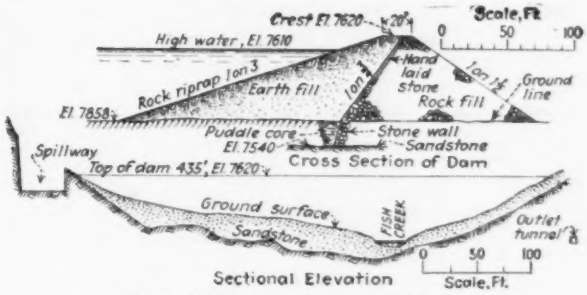


FIG. 3—EARTH AND ROCK-FILL DAM

4,800 sec.-ft., which is more than four times the estimated maximum flood flow of the creek.

A fissure spring was opened up in the floor of the tunnel near the lower end, and in lining the tunnel this spring was bottled up and conducted through the concrete floor in a 3-in. pipe. A similar spring in the core trench at the south abutment was about 10 ft. in elevation and 40 ft. upstream from the other, and came from a fissure in the sandstone. The water was led through the puddle core in a 3-in. pipe discharging into the French drain in the creek bed.

The grade of the tunnel for the lower 150 ft. intercepted a shale stratum. Here concrete lining for the roof and side walls was reinforced with steel, while the 6-in. floor was of plain concrete. In September, 1927, it was found that the floor resting on the shale formation had cracked along the center and heaved about 6 in. It was concluded that this action was due to the swelling of the shale under the floor, which had become saturated with seepage water. There was no evidence of movement in the side walls or roof.

Railroad Relocation—To bring the Scofield branch of the Denver & Rio Grande Western Railroad above the high-water contour of the reservoir, it had to be relocated for 5.6 miles, with a maximum compensated grade of 1.8 per cent below the dam and a level grade around the reservoir. The track is now 37.5 ft. above the high-water contour. The district deposited with the railroad company the estimated cost and the railroad company assumed the responsibility of making the change.

Financing—To finance this project, the district voted a $750,000 bond issue. This was sold at 80 per cent and the proceeds were expended approximately as follows: Dam, $130,000; railroad relocation, $246,000; water

FIG. 4—TYPICAL CONSTRUCTION WORK
In center, sheeted trench for core wall. Rock fill and dump trestle at left. Earth fill with riprap slope at right.

rights, $67,000; reservoir site, $90,000; engineering and legal services, $31,000; miscellaneous, $36,000; total, $600,000. On this basis the cost per acre-foot of water stored in the reservoir is $12.30 and the cost to the consumer over the twenty-year life of the bond will be $26 per acre-foot.

Settlement and Seepage—During 1926, while the dam was under construction, 13,000 acre-ft. of water was stored and used during the irrigation season. In 1927 there was 47,000 acre-ft. stored, with the water within 7 ft. of the high-water contour. In September, 1927, the writer found that the dam had settled 18 in. at the center, with practically no settlement near the ends. It also showed a settlement of 6 in. more on the rock-fill side than on the earth-fill side. This unequal settlement was noticeable on top of the dam for the greater portion of its length. No longitudinal cracks developed and the single transverse crack was near the spillway end, extending a short distance down from the top. This crack was due to the structure settling at the center.

Early in 1927 seepage water began to come through the construction joints of the concrete lining in the lower end of the outlet tunnel, increasing until it reached 1½ sec.-ft. in June. At the same time the water coming from the 3-in. spring pipe in the tunnel increased so that by the latter part of June it was spouting a foot above the top of the pipe, showing that it was under some pressure. At that time seepage water began to come from the left bank of the creek at the lower toe of the dam, increasing during May and June. When this seepage water was collected and run over a weir, it was found to fluctuate from a minimum in the early morning to a maximum in the late afternoon, practically doubling in volume in this period. Observations showed a similar fluctuation in the water entering the tunnel and that water had a decided sulphur odor. These observations led to the conclusion that the water was not coming from the reservoir, but from melting snows on the hills, which found its way into the fissured formation of the sandstone on the south side. No such seepage appeared on the north side of the canyon wall. In September, 1927, with approximately 30,000 acre-ft. of water in the reservoir, the seepage along the creek bank had disappeared entirely and the seepage into the outlet tunnel was only a fraction of that in May and June.

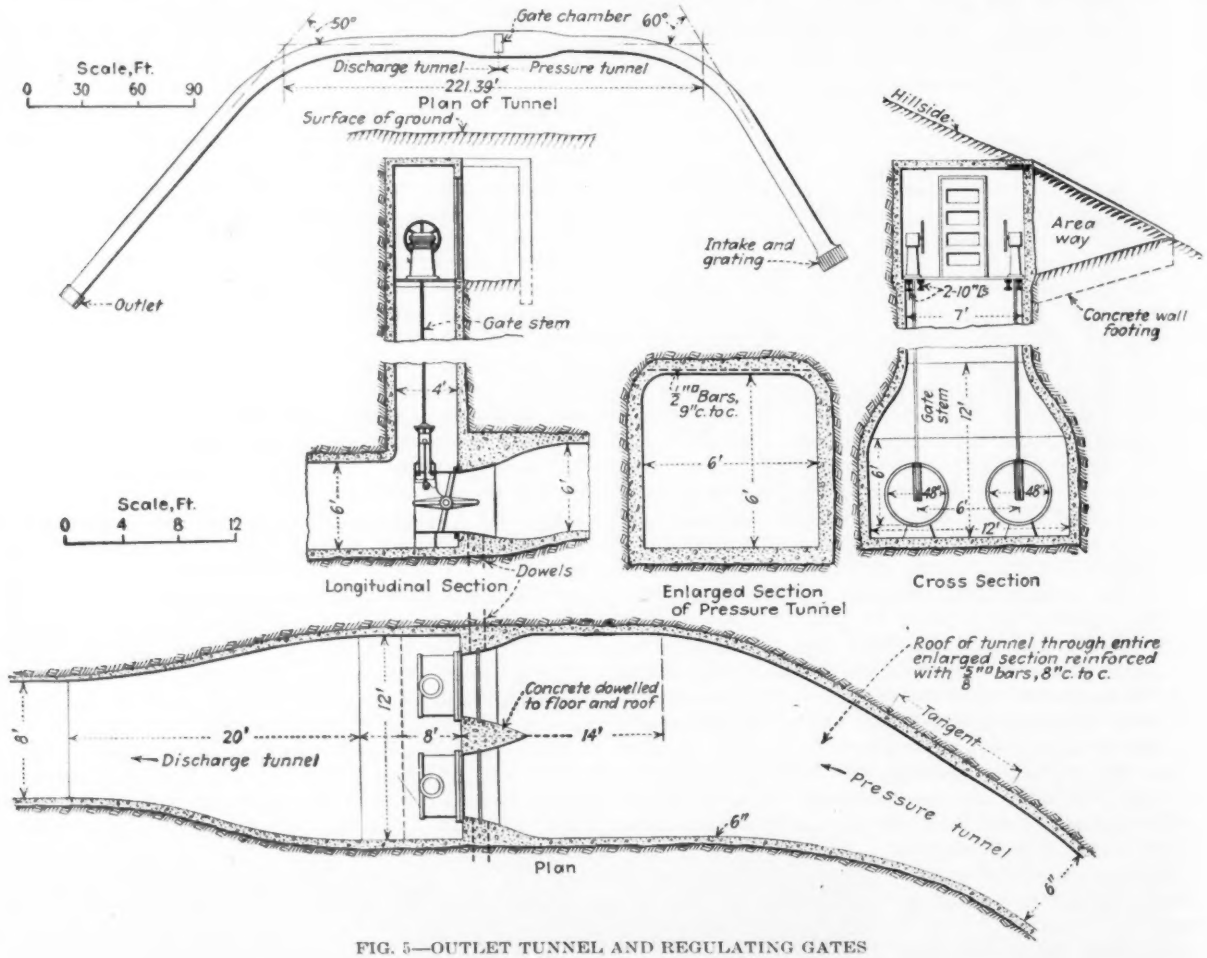


FIG. 5—OUTLET TUNNEL AND REGULATING GATES

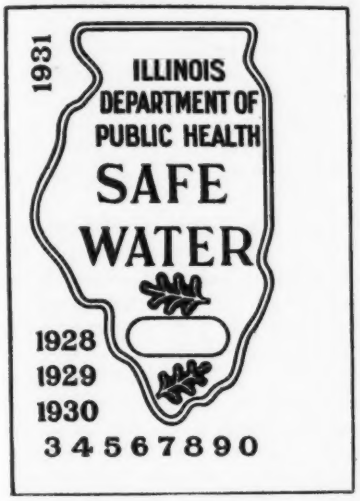
Engineers and Contractors—As engineers for the Price River Water Conservation District the writer's firm, McGongale & Ullrich, Salt Lake City, Utah, designed and supervised the construction of both the dam and the railroad relocation. J. H. McNichols was resident engineer. The Reynolds-Ely Construction Company, Springville, Utah, had the contract for both works. A feature in the bidding was that contractors were required to bid a lump sum price for building the dam and a lump sum price for the railroad relocation. There were no extras on this work.

Solving Day-by-Day Water-Works Problems

What the Engineer Has Developed in Kinks and Detail Practices

Safety Seals for Illinois Water

IN CONNECTION with its inspection of semi-public water supplies, particularly at tourist camps and along highways, the Illinois State Department of Public Health has been marking such supplies as were found safe. Originally this was done by lead seals fastened to the pumps with copper wires, but many of these were stolen; therefore the seals for 1928 and future years will be decalcomania transfers of the design shown herewith. They are about 3x4 in., having the shape of the state in bronze color, with lettering in black and yellow. Such seals have been used with success in West Virginia. Although they will stand the weather without any protective coating, the Illinois department plans to cover them with a clear varnish.



"SAFE WATER" SEAL IN ILLINOIS
Original about 3x4 in., with bronze body color, black and yellow border and lettering.

On account of the interest shown by county superintendents of schools and county home bureaus, it is intended to apply the seals also to the pumps of good wells at country schools. Harry F. Ferguson, chief sanitary engineer of the State Department of Public Health, is in charge of this inspection and marking system.

Starting Washed Filters

By August V. Graf
Chief Chemical Engineer, St. Louis Water-Works

AT ALL new filter plants, the rewash or filtered-water waste valves and appurtenances are being omitted as unnecessary. Some plants are installing them, but instead of having these valves hydraulically operated from the table they are hand operated and are used only to drain the filters. A great many of the older plants, although equipped to waste the first water filtered after a filter has been washed, have found it undesirable to do this. When a filter is put into service after washing, the first water that passes is the clear wash water that was in the gravel and underdrain. This is followed by the turbid water in the sand and then by the imperfectly filtered water. At most plants the rate of filtration after washing is set at the rate at which the other filters are being operated. At St. Louis, regardless of the rate of filtration, the rate on the washed filter is set at 0.5 m.g.d. and is allowed to run for 1 hour before the rate is raised to that of the other filters. The results of a great number of tests show that the turbidity obtained is never as great as it is when the rate is immediately increased to the full amount. After one hour at the 0.5-m.g.d. rate an increase in turbidity is noted when the rate is increased, but the maximum turbidity obtained is less than one-third as great as when the filter is set at the full rate immediately after washing.

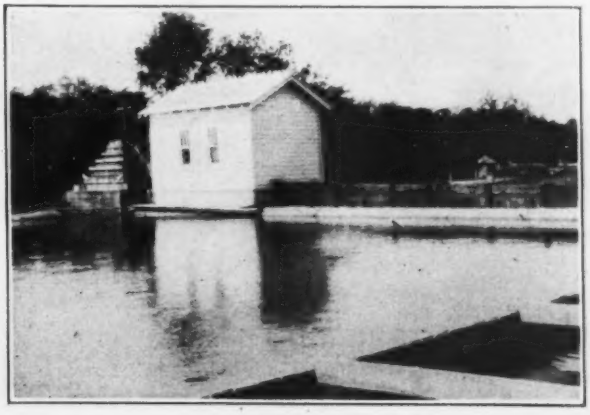
At the new Howard Bend plant, being built on the Missouri River, there will be twenty filters, each of 4-m.g.d. capacity. A new device will be used at this plant to increase the rate of filtration from zero to the desired rate in any time up to one hour. This device will slowly increase the rate so that at first, when there is but little coating on the surface of the filter, the rate will be very low, and as the coating increases the rate will be raised. Numerous tests made at the Chain of Rocks plant with this method of operation yielded a minimum of turbid water. This device was suggested by us and is being worked out by the manufacturer of the controllers for the new plant.

Remodeling a Small Water-Purification Plant

By James L. Barron
Assistant Engineer, Kansas State Board of Health, Lawrence, Kan.

FOLLOWING several years of unsatisfactory operation, both from a physical and a bacteriological standpoint, the city officials of Burlingame, Kan., asked the state board of health to outline modernization of its water-purification plant at moderate expense.

The old plant, which had been in operation since 1916, obtained water from an impounded supply in Dragoon Creek and discharged it at a rate of 250 g.p.m. into a rectangular concrete-lined 250,000-gal. settling basin. Alum solution for coagulation was applied by gravity to the raw water line from a solution tank in the top of the filter house. No mixing device was provided, nor were there adequate facilities for distributing the flow or for securing displacement through the basin. The remainder of the plant consisted of one rapid sand filter unit incor-



A REMODELED SMALL PURIFICATION PLANT
The new aerator, chemical house and mixing flume appear across the basin, while the stilling baffle is shown in the foreground.

porating a combined air and water wash. The filter effluent was treated by means of chloride of lime solution. The only change made in the plant from 1916 to 1927 was the elimination of the air wash.

The improvements which have been made are partly shown in the accompanying illustration. They consist of a cascade aerator, mixing flume, chemical house, basin stilling baffle, additional sewer capacity for wash water and machines for the application of lime, alum and chlorine. The aerator, similar to that described in *Engineering News-Record*, Oct. 14, 1926, p. 634, has a tee at the base of the riser pipe with a screw plug. By removing the plug the aerator may be bypassed and valves are unnecessary. The catchbasin of the aerator discharges directly into a flume 12 in. wide, 18 in. deep and with a grade of about 1.5 per cent. The chemical house is built over the flume adjacent to the aerator and the alum and lime machines discharge directly into the flume. Picket baffles, made of lath, are set in the flume at intervals and accomplish a thorough mixing of the chemicals. The flume discharges across the end of the basin back of the stilling baffle. This baffle is placed at the toe of the slope and consists of 1x8-in. boards set on a frame vertically with ½-in. cracks between boards. This baffle has more than doubled the actual detention period of the basin.

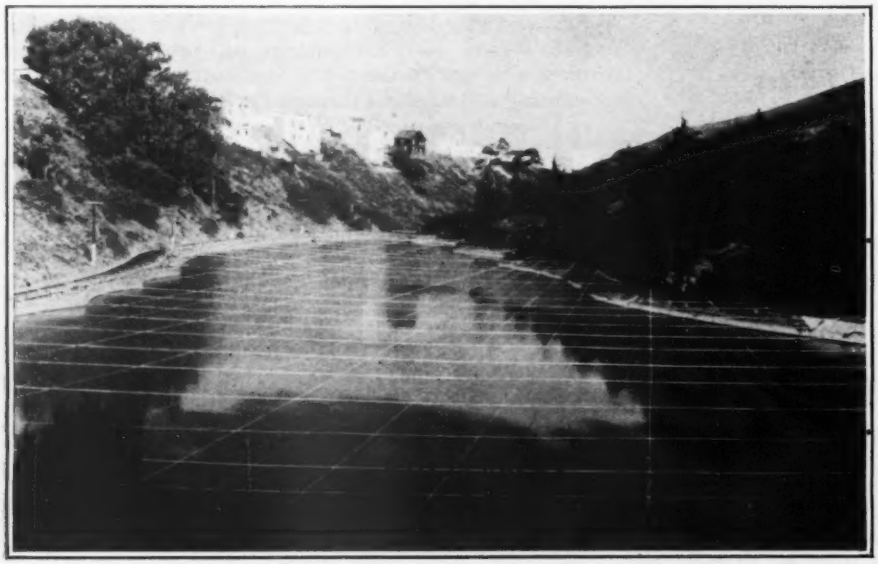
The plant is now capable of removing objectionable tastes and odors by aeration, alum consumption is greatly reduced, highly turbid water is easily handled, red water troubles are corrected, the filter is restored to normal efficiency and effective sterilization is secured by using liquid chlorine. Principal items of cost in the remodeling are included in the chemical feed equipment. Ed Thomas is water superintendent and supervised the improvements.

Cross-Wires Strung Over San Francisco Reservoirs Keep Seagulls Away

SEAGULLS became a nuisance at San Francisco about ten years ago when they formed the custom of daily leaving their usual habitat along the waterfront and flying inland far enough to infest the city reservoirs of the Spring Valley Water Company. Attempts to scare them away were of no avail and eventually the company had to roof those reservoirs where covering was feasible, as noted in *Engineering News-Record*, Nov. 5, 1925, p. 764. Some of the reservoirs could not be covered economically, chiefly because of their size and depth, and in those cases attempts were made to drive the birds away by shooting. An automatic exploder was finally installed which was fairly successful but was expensive to maintain and in other respects not wholly satisfactory.

Later it was found that the seagulls would not pass through a network of wires 40 to 50 ft. apart each way. Practically all of the reservoirs of the Spring Valley Water Company located near salt water have been so protected, including a reservoir 1,000 ft. long and 600 ft. wide. Even in this large area the wire network has thus far been entirely successful.

For the smaller reservoirs, No. 9 galvanized-iron wire was used fastened to 2-in. pipe supports driven into the ground; where the spans were so long that wires of this size would not be strong enough to withstand the necessary strain, wire cables of ¼- to ½-in. diameter were strung first to support the smaller wires. The wires are pulled taut enough to keep the low point on the curve about 1 ft. above high-water level in the reservoir. On some of the longest spans, pipes resting on the bottom of the reservoir and extending up to the desired heights were used to provide intermediate supports and prevent too much sagging.



WIRE NET THAT SCARES OFF SEAGULLS AT LAGUNA HONDA RESERVOIR, SAN FRANCISCO
A very recent installation. This reservoir is 35 ft. deep and roofing would be expensive.

Solving Day-by-Day

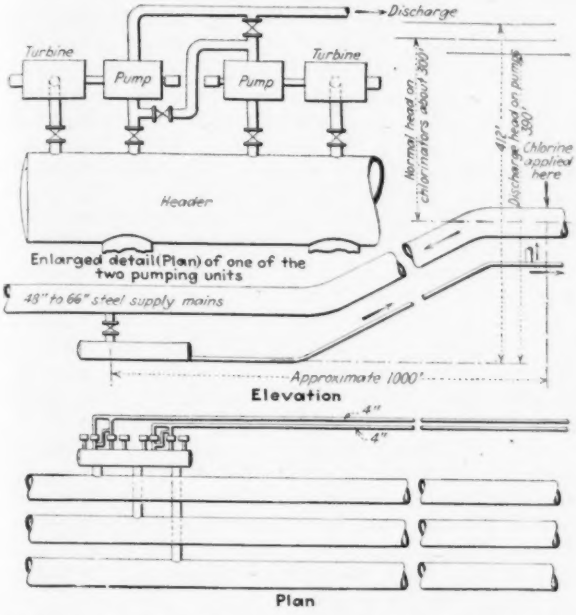
Turbine Pumping Units for Lake Youngs Chlorinators at Seattle

IN PLANNING a method of applying chlorine treatment in three water-supply mains (48-, 60- and 66-in.) leading from the Lake Youngs storage reservoir recently completed for the Water Department of Seattle, Wash., no water supply under sufficient pressure to inject chlorine was available and it was necessary to develop some highly dependable means of maintaining the necessary pressure. Electric current was available, but because of the possibility of power going off, it was thought preferable to have some source of energy independent of a transmission line. In addition to the high pressure for the chlorinators, a lower-pressure supply was also needed at the control works for washing screens, for domestic supply in the attendants' cottages and for watering the grounds. A source of water pressure believed to satisfy all these requirements is now being in-

Water-Works Problems

stalled in the form of centrifugal pumps direct-connected to hydraulic turbines operated by water pressure from a low point in the mains near the control works. Thus there is assurance of a power supply so long as there is water in the mains to be chlorinated.

This plan was possible because the city now has an



SKETCH OF TURBINE PUMP SYSTEM FOR CHLORINATORS

ample water supply and the amount to be put through the turbines and wasted will be of no consequence. The point selected for the installation is about 1,000 ft. from the control works where the mains, under a normal head of 121 ft., cross a small streambed into which the turbine discharge can be wasted. To make the turbine supply independent of any one of the three mains, all three are tapped into a header from which the turbines are fed.

Four turbines, each direct-connected to a centrifugal pump, are being installed, arranged to be operated singly or through two pumps in series, as may be desired. Thus two complete and independent units are provided, either of which will meet the high-pressure requirements of the chlorinator installation. Any single turbine and pump will meet the requirements of the low-pressure system.

The turbines are designed to operate under a variable head, ranging, with reservoir fluctuations, from 98 to 134 ft. The pumps are being equipped with double-suction, balanced bronze impellers and cast-iron casings designed to withstand a pressure of 300 lb. per sq.in. They are fed from the same header that serves the turbines and with a series connection each pair of pumps is to take water under a normal head of 121 ft. and lift it to an elevation 390 to 412 ft. higher than the pumps, delivering at a rate of 120 gal. per minute. Each pair of pumps is being provided with a 4-in. discharge line leading to the control works, where connections are such that either line can be used to serve the high-pressure chlorination system or the low-pressure general utility service around the plant.

For the foregoing information *Engineering News-Record* is indebted to L. Murray Grant, superintendent water department, and James M. Ferguson, assistant engineer.

Lowering a 400,000-Gal. Elevated Tank

By Eldon S. Clark
Assistant Engineer, Metcalf & Eddy, Boston, Mass.

IN THE program for strengthening the water-works of Quincy, Mass., was included the task of lowering a 400,000-gal. elevated tank. This tank, erected in 1914 to provide storage for the Hough's Neck section of the city, was built at such an elevation that, owing to the long distance from the point of supply and the comparatively small size of pipe, it seldom filled more than a third of its depth. In strengthening the distribution system, it was decided that greater economy would result from lowering the tank so that its storage capacity would be completely available than from the installation of mains sufficiently large to insure proper fire service without storage or of sufficient size to make the tank effective at its initial elevation.

The tank is 40 ft. in diameter, about 30 ft. deep in the cylindrical portion, with a hemispherical bottom, and is supported on eight columns, made up of three panels each about 33 ft. high. The tank is located on a point projecting into Boston Bay, and is, therefore, nearly surrounded by salt water.

The tank and tower were dismantled and re-erected, omitting the middle sections of the columns. Since it was necessary to place the bases of the columns on a circle of a smaller diameter, holes were drilled in the concrete footings and the new anchor bolts wedged and grouted into place.

The method of dismantling was, in general, the same as that used in erection with the operations reversed. Rivets were cut out and replaced by bolts which held the tank plates together while the remainder of the rivets were being cut. Preliminary to dismantling the tower, the threaded ends of the cross-bracing, where they were screwed into the clevices, were wrapped with waste kept constantly wet with a rust softener. No great difficulty was experienced in removing this cross-bracing, which was unscrewed until relieved of load and the bearing pins driven out. The rivets in the column splices next were replaced with bolts, a bent at a time, the columns being lowered by means of a gin pole erected on one of the columns or on the horizontal struts. The 5-ft. diameter uptake pipe was lowered without dismantling.

Parts of the structure were found in very bad condition. It was necessary to replace the roof, roof beams, circular girder supporting the roof, and the two top courses of tank plates. All of the plates above the lower third of the tank were badly pitted, particularly next to the calking edge of the lapping plate. However, it was found that the section of most of the plates, even where badly pitted, was adequate to carry greater stresses than the joints could take, so the plates were re-used. The protection afforded by proper painting was clearly indicated, for the tower was practically undamaged by rust, and the outside of the tank, which had been kept painted, showed very little deterioration. Copper-bearing steel was used in the new roof, since the difficulty of painting the under side of such a roof is considerable.

The steel was cleaned on the ground by sand blasting. The structure was given one coat of red lead and oil on the ground and two coats after erection. The cost of the work to the city of Quincy, exclusive of new steel, was $13,500. It was done under contract by the Chicago Bridge & Iron Works, which built the tank in 1914. John J. Cosgrove was commissioner of public works of the city of Quincy. Metcalf & Eddy, of Boston, made plans for and supervised the work of reinforcement of the water-works plant, with the writer in local charge.

Device for Collecting Deep Water Samples

By Edward S. Hopkins
Principal Sanitary Chemist, Bureau of Water Supply, Baltimore, Md.

FOR the purpose of securing a sample of water at depths varying from 10 to 60 ft. and to enable the operator to work from bridges 20 to 80 ft. above the surface, the apparatus shown in the accompanying illustration has been developed. It includes two distinct parts, a depth sampler and a collecting bottle. The depth sampler, Fig. 2, is a copper funnel approximately 7 in. in diameter and 6 in. high, the bottom being weighted with about 5 lb. of lead fastened to the sides. A ring for lowering the sampler is fastened to the supporting iron framework, and a rubber hose connection, ¼-in. internal diameter, leads to the collecting bottle. This collecting bottle, shown in Fig. 1, consists of a 1,000-c.c. wide-mouth bottle closed with a rubber stopper carrying ⅛-in. inlet and outlet pipes. The bottle sets in a galvanized-iron container about 5 in. in diameter and 6 in. high, which is supported by an iron framework about 7 in. high. The bottom of the container is made of brass wire, allowing proper drainage. The stopper is held in place by a clamp arranged to fasten under the lip of the bottle and regulated by a screw. The piping is fastened to the frame by a sliding band, which permits removal of the stopper from the bottle. The ¼-in. standard check valve is closed against air when suction is applied, being released when the vacuum is broken. Rubber hose connections lead from the depth sampler to the bottle and to the suction pump. The usual laboratory suction flask is attached in the line on the bridge and suction applied by a hand vacuum pump.

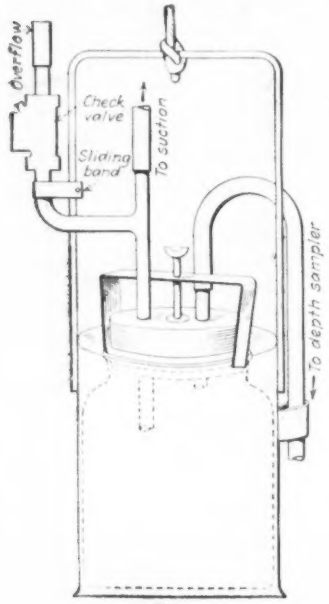


FIG.1

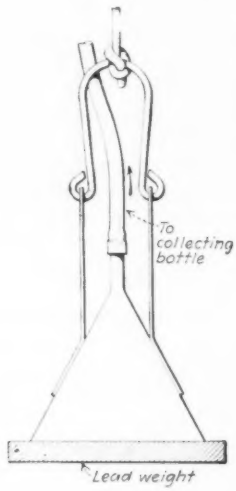


FIG.2

FIG. 1 (AT LEFT)—SAMPLE COLLECTING BOTTLE.
FIG. 2 (AT RIGHT)—DEPTH SAMPLER.

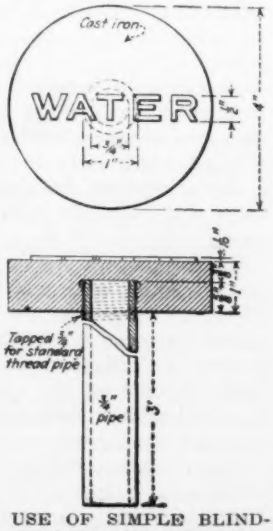
In operating in equipment the depth sampler, provided with the necessary length of hose, is lowered with a rope to any depth desired from the bridge, and the collecting bottle is similarly suspended on a separate rope at the surface of the water. This should be done simultaneously, thus requiring two men for the task. Hose connection is then made to the suction flask and to the pump on the bridge. If the height of the bridge above the water is less than the maximum water lift (about 28 ft.), the suction flask will fill and should be emptied and refilled a sufficient number of times to assure a comparable sample in the bottle. If the height is greater than the maximum lift, the water will remain in the hose at this point. Release of the vacuum will allow this water to drain through the check valve. This alternate application of suction and drainage is continued until a comparable sample is obtained. When collecting a sample in 50 ft. of water and from a bridge 70 ft. above the surface, it was found that pumping for one minute filled the bottle; for one-quarter minute additional pumping the flow was raised to the maximum level for each subsequent drain. When a comparable sample is obtained, the apparatus is drawn to the bridge, the bottle removed and the water used for subsequent analysis.

Solving Day-by-Day

Experiences With Blind Taps and a New Marker

By Frederick W. Albert
Engineer in Charge, Water Department, Knoxville, Tenn.

IN RAPIDLY developing sections of Knoxville, Tenn., the water department's installations invariably include blind taps laid from the main to the curb for all undeveloped property. Heretofore the blind tap has been marked with a box placed over the curb cock. These curb cock-boxes cost $1.33 complete, delivered. Recently the water department abandoned the use of the curb cock-box, incorporating the curb cock in the meter casing, thus reducing the hazard that invariably follows the installation of the curb cock-box, through the loss of the lid and the possible damage to the public thereby. It likewise places the curb cock in immediate proximity to the meter, enabling the delinquent account or off-and-on man to watch the meter, as



USE OF SIMPLE BLIND-TAP MARKER EFFECTS BIG SAVING IN KNOXVILLE

Water-Works Problems

well as permitting the meter reader to observe the curb cock.

In view of our new meter installation, the department decided that it was an unnecessary expense to install curb cock-boxes over blind taps when subsequent installation of the meter and the continuance of the service to the property line would, under our present scheme, make the curb cock-box superfluous. However, a marker of some sort had to be provided so that the curb cock and the blind tap would not be lost.

It was first proposed to cut the initial W on the curb, but as practically all of the water department work in the improvement district is completed before the gutters and curbs are installed, this was decided to be impractical. A simple marker was finally designed which could be returned to stock, when the meter was installed, and used again later.

The marker is shown in the accompanying illustration. It is made up of a cast-iron top and of scrap ¾-in. service pipe. Under a competitive bid, a local foundry agreed to furnish the top for 13c. in lots of 1,000. Tests have shown that the scrap pipe can be cut and threaded for 3c. per length. The scrap pipe is estimated at 2c., making total cost of the marker 18c. This results in a net saving to the department of $1.15 per blind tap, through the use of a marker instead of a curb cock-box. Even if new ¾-in. pipe were used, the net saving would be $1.07.

The present program of improvement districts shows a saving of $2,500 to the water department through this change, it being assumed that the labor of installing the curb cock-box and marker would be the same in either case. One company dealing in water-works equipment was so impressed with the idea that it immediately got out a marker embodying the Knoxville idea, but costing more, as well as appearing as a more finished and commercial article.

Locating Water-Bound Leaks by Dye-Test Metering

By J. B. Eddy
Engineer, Water Pipe Extension, Bureau of Engineering, Chicago

In many of the older sections of Chicago the water mains and lead service pipes were laid in wet marshy ground (mostly water-bearing sand) 40 to 60 years ago. Sewers were laid at about the same elevation as the water mains and in many streets at elevations above the water mains. As new pavements were put down, the street grades were raised until these water mains and service pipes now have from 10 to 14 ft. of cover. These mains and service pipes are invariably covered with water and the location of underground leaks under such conditions is almost impossible when ordinary methods are used. The sounding rod and aquaphone cannot be used where mains are at such extreme depths and where no sound of leaking water is transmitted, as is the case with water-bound leaks.

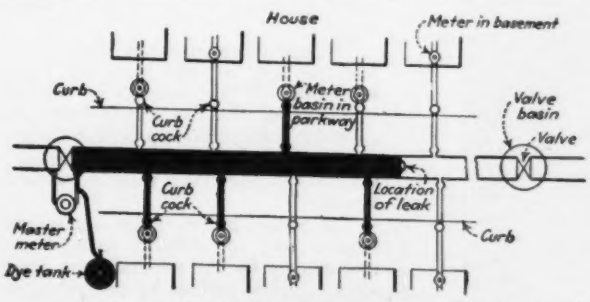


FIG. 1—DYE-TEST METHOD FOR LOCATING UNDERGROUND LEAK

A new method of testing to determine the location of underground leaks has been worked out by the engineers of the city bureau of engineering and has been called the "dye method." It may be briefly described as follows, referring to Fig. 1:

FIG. 2—DYE TANK AND METER ARRANGEMENT FOR LOCATING UNDERGROUND LEAKS

After a section of main has been isolated and the service pipes have been shut off, a master meter is inserted at one end of the section under test by bypassing a closed valve. When leakage is indicated by the master meter, a vegetable dye (fuchsine) which colors the water red is passed into the pipe at the location of the bypassed valve adjacent to the master meter. This dye is contained in a tank under sufficient pressure so that it can be forced into the main under test. The rate in feet per second at which the dye-colored water in the main is moving can be determined by considering the cross-section of the main and the volume of water being recorded by the master meter. After this rate has been determined the service pipe is disconnected at the first house meter and the water drawn off in a volume equal to the contents of the service pipe. If the dye has reached this point in the computed time, the water is shut off on the service pipe and the next service pipe opened and similarly tested. When a point is reached where the dye does not come through the service pipe in the time computed, it is necessary to draw off the uncolored water until the dye-colored water appears. The water thus drawn off is measured, and when the volume of this is divided by the area of the cross-section of the pipe, the distance from the service pipe under test back to the point of the leak is determined. In this way the location of an underground leak can be determined without the use of sound instruments or without excavating at random.

News of the Week

Current Events in the Civil Engineering and Contracting Fields

Pleasant Valley Dam Leak Is Believed Now To Be Under Control

Designers and Railroad and State Officials Agree That Stability Is Not Impaired

THE serious leakage which was discovered Monday, May 21, in the Pleasant Valley irrigation dam near Scofield, Utah, is believed to be under control. Notice of the break and a brief description of this earth and rock-fill structure appeared in *Engineering News-Record* May 24, 1928, p. 827. The design and construction of the dam are described in the present issue by C. J. Ullrich, engineer on the dam.

A telegram received from Mr. Ullrich on May 24 states: "Leak started near top center of dam apparently through transverse crack in upper portion of earth fill. Gap is 150 ft. long and extends from the water edge of reservoir to the upstream face of the rock fill. The rock fill shows no displacement. The quantity of water going through the rock fill was as high as 50 sec.-ft. Rock-fill portion of dam prevented disaster and demonstrated its value in this type of structure. Forty-five thousand acre-feet of water in reservoir."

On May 28 W. W. De Berard, associate editor, *Engineering News-Record*, gave the following fuller telegraph details:

"Although the serious leakage was

(Continued on p. 784)

Marquette Planning New Lines

The Pere Marquette Railway has applied to the Interstate Commerce Commission for authority to construct new lines from Green Oak to Wixom, a distance of 7.8 miles, and from Pontiac to Richmond, 30 miles. These lines, together with certain others already authorized, will shorten the distance between Chicago and Buffalo by 35 miles.

Springfield Authorized to Build Cobble Mountain Reservoir

A legislative bill authorizing Springfield, Mass., to issue $4,500,000 of bonds in addition to $2,000,000 already authorized to enlarge its water-supply facilities has been signed by the Governor. The largest feature of the work is to be the Cobble Mountain dam and reservoir. Hydro-electric development at the dam, with the sale of power to the Turners Falls Power & Electric Company, is included in the project. The dam will be a hydraulic fill, from 235 to 245 ft. high above the ledge in the stream, 700 ft. long on top, and will impound 22,250 m.g. of water, of which 20,000 m.g. will be available for power. There will be 452 ft. of head available for developing hydro-electric power in a plant with a proposed output of 30,000 kw. From the dam the water will return to the city supply at the present intake reservoir, and thence be brought to the city through its present 42-in. lock-bar steel pipe line or the new 48-54-in. welded steel line now under construction. E. E. Lochridge is chief engineer.

International Newsreel Photo

EMERGENCY REPAIR WORK ON NEW PLEASANT VALLEY DAM NEAR SCOFIELD, UTAH

Administrative Board Engineering Council Meets in Milwaukee

Discusses Various Bills of a Technical Nature That Are Now Pending Before Congress

THE administrative board of the American Engineering Council, at its recent meeting in Milwaukee, confined its activities largely to consideration of the various bills of an engineering nature that are now pending in Congress. The business reports of the various officers of the board were approved, and a committee submitted several proposed changes in the constitution, bylaws and standing rules which are to be presented to the Council. Resignation from the board of E. S. Lanphier, New Orleans, representative of the Louisiana Engineering Society, was announced. A. A. Krieger automatically becomes a member of the board.

The administrative board indorsed the creation of a commission of engineers, as proposed in the Douglas bill, to investigate the physical problems connected with flood control and development of the Colorado River. The program contemplated by the bill was approved "subject to the report of this commission of present expenditures on the Colorado River confined only to flood protection."

Nicaragua Canal Opposed

Although the Nicaraguan Canal was held to be both unnecessary and undesirable at this time, the Senate bill sponsored by Senator Edge, which provides a means of bringing up to date available information on the proposed canal, was indorsed.

The report of the committee on street signs, signals and markings was adopted, and the executive secretary was authorized to publish it.

W. B. Powell, Buffalo, N. Y., was appointed to represent the Council at the conference of the Traffic Institute in St. Louis.

The executive committee indorsed the Browne bill, introduced in the House, providing for "the conduct of scientific investigations by the Forest Service to discover economically practical methods of the disposal of the waste materials of pulp and paper mills without polluting streams."

The Senate bill to create a prosperity reserve and to stabilize industry and employment by the expansion of public works during periods of unemployment and industrial depression was favored by the board in its revised form.

Washington Notes

Barge Bill Passes the Senate; No Report Made on Wyant Bill; Hydraulic Laboratory Bill Fails

AFTER hope had been abandoned for the passage of the bill authorizing the purchase of increased equipment for the government barge line operations, the measure was called up in the Senate by Mr. Reed, Missouri, and passed. Vigorous opposition was voiced by Senators King, Utah; Copeland, New York, and Bruce, Maryland. A part of the opposition was based on the contention that sufficient opportunity had not been given to all concerned to be heard. The threat to filibuster against the bill did not materialize, so the measure was brought to a vote without a roll call. As this is written the differences between the measure passed by the House and that passed by the Senate have not been composed, so there is still doubt as to the outcome of the legislation.

Signs Highway Bill

An announcement on the floor of the Senate by Mr. Oddie that he would oppose adjournment until the danger of a pocket veto for the highway bill had passed was followed shortly by the return to the Senate of the bill duly signed by the President. The measure authorizes the continuance of federal-aid payment at the rate of $75,000,000 annually, in addition to provision for forest roads and trails at the rate of $7,500,000. The delay in signing the bill led its friends to fear a veto.

No Report on Wyant Bill

In announcing that his committee was not able to make its report on the Wyant public works bill at this session, Representative Wilson, South Dakota, declared that it is useless to try to do anything with such a controversial measure until more members of Congress can be induced to take an active interest in the subject.

Campbell Bill Waits

Having been refused a place on the legislative program, the Campbell bill, sponsored by the Associated General Contractors, will go over until December. Much of the construction work that would come under the provisions of the proposed bill will not be under way until next December, Representative Campbell, Pennsylvania, pointed out. For this reason, coupled with the fact that the Corps of Engineers has accepted the principles of the bill, in its new regulations governing the handling of work, Mr. Campbell thought it better to make no effort to pass the bill under suspension of the rules.

Veto Sustained

After the Senate had voted 57 to 22 to override the President's veto of the bill authorizing a highway construction program in the public lands, the necessary two-thirds vote could not be secured in the House to override the veto, so the bill failed. The American Association of State Highway Officials immediately directed a letter to each member of the Senate and of the House who voted to sustain the veto, asking for suggestions as to how the government's own lands are to be supplied with roads if the policy outlined by the President is to be upheld.

Hydraulic Laboratory Loses

Not only did the rivers and harbors committee of the House refuse to approve the bill passed by the Senate, authorizing the establishment of a hydraulic laboratory in the Bureau of Standards, but it also refused to approve the bill with an amendment which would permit the Corps of Engineers to establish its own hydraulic laboratories at any point or points along the river.

Water-Works Men Meet on West Coast for First Time

The annual convention of the American Water Works Association will journey to the Pacific Coast this year for the first time in its history. The meeting is scheduled to be held at the Fairmont Hotel, San Francisco, June 11-15. An annual meeting in the far West is a strict departure from past practice, as may be seen from the accompanying map. Listed below are the cities and the years in which they entertained the convention. On the map the number following each city indicates the number of times the convention has been held in that particular city.

CONVENTION CITIES OF AMERICAN WATER-WORKS ASSOCIATION
Numbers indicate time association has met in each city

Atlanta	1895		
Boston	1885, 1906	Minneapolis	1887, 1894, 1913
Buffalo	1883, 1898, 1919, 1926	New Orleans	1910
Chicago	1890, 1902, 1927	New York	1892, 1901, 1916, 1924
Cincinnati	1884, 1915	Philadelphia	1891, 1914, 1922
Cleveland	1888, 1921	Rochester	1911
Columbus	1882, 1899	St. Louis	1881, 1904, 1918
Denver	1886, 1897	Toronto	1907
Detroit	1903, 1923	Washington	1908
Indianapolis	1896, 1905	West Baden, Ind.	1905
Louisville	1889, 1912, 1925	Richmond, Va.	1900, 1917
Milwaukee	1893, 1909		
Montreal	1920		

Structural Steel Welding Program Soon to Be Under Way

The two sub-committees, specimen design and specimen procedure, of the structural steel welding committee, organized under the auspices of the American Bureau of Welding, have completed their preliminary work for a comprehensive series of tests on scientifically designed welded joints.

The sub-committee on specimen design laid out 191 different designs and sizes of welded joints whose tests would give unit values applicable to conditions of design most commonly met in structural work. A marking system was developed that would identify specimens prepared in different shops.

The sub-committee on specimen procedure took these designs and laid out a procedure, specifying how multiple specimens of each type and size should be made up, including the qualification of welders, the technique to be followed, supervision and inspection. In order to obtain a preliminary trial of the specifications covering the making and testing of specimens, several hundred pilot specimens were made and tested under the supervision of Prof. Peter Gillespie at the University of Toronto. These pilot tests brought forth the desirability of a number of changes in the specimens and in the procedure specifications.

Checks from contributors to the work of the committee have been received. Steel has been pledged by the United States Steel Corporation and the Bethlehem Steel Company. About 40 fabricating shops have indicated their willingness to participate in the program by making up specimens. In addition, a number of university laboratories and the Bureau of Standards have expressed willingness to do the testing work. The National Research Edwards, chief engineer, American Council is acting as treasurer. J. H. Bridge Company, New York City, is chairman of the structural welding committee.

Bids Wanted for Mineral Ridge Dam

Bids for the Mineral Ridge dam, to provide storage for the water supply of Youngstown, Ohio, are to be received until June 12. The dam will be about 60 ft. high above the streambed, nearly 3,700 ft. long over all, of earth with a concrete core-wall and a concrete spillway. Some of the main items are: Removal of top soil, 8,600 cu.yd.; earth excavation, 190,000 cu.yd.; rock excavation, 10,000 cu.yd.; earth embankment, 166,000 cu.yd. for dam and 7,200 for roads; replacing loam, 5,600 cu.yd.; concrete, 50,000 cu.yd. The dam site is on Meander Creek, 2 miles south of the center of Niles. W. H. Dittoe is chief engineer of the Mahoning Valley Sanitary District, for which the joint water-supply works for Youngstown and Niles are being built.

Pleasant Valley Dam Leak Now Under Control

(Continued from p. 872)

discovered by a watchman at 5 o'clock on Monday morning, a depression in the earth crest the size of a large room was noted on the previous afternoon by one of the directors of the Price River Water Conservation District. This depression was not considered of moment because it was above high-water level. When the leak was first discovered, the watchman by telephone notified the towns of Price and Helper. The citizens were brought to the streets by a fire alarm and were advised to seek hillsides.

"The watchman had also noted leakage 90 ft. wide pouring out from the toe of the dam. The French drain in the creek bed was running more than full. By 8 o'clock Monday morning (May 21), when a railroad work train arrived from Price with men, sandbags and equipment, the hole at the water's edge was 90 ft. along the axis of the dam and 35 ft. wide. Ultimately the hole enlarged to 180x40 ft. Soundings indicated that the slope of the crater-like hole extended nearly to streambed. Water was never more than 18 in. lower in the hole than in the reservoir, and was brought back to the level of the reservoir as soon as sandbags were dumped along the upstream face of the rock fill. A rough estimate places the maximum leakage at 200 sec.-ft., later reduced to 50 sec.-ft.

"Emergency repair work consisted in placing sandbags 5 ft. high around the crest of the break. As these bags had been placed over riprap, the water was forced through the latter, at a velocity that carried away sufficient material to settle the sandbag dam about 5 ft. by the second evening. Following this first procedure, efforts were directed toward sealing the upstream face of the rock fill by dumping sacked cinders and sandy loam into the hole, starting at the ends and working toward the center. The cinders proved to be the more effective. By Tuesday night 20,000 sacks had been placed and in addition approximately an equal amount of loose material from the dam crest had been thrown into the hole. By Friday, May 25, leakage had stopped.

"Apparently the leakage started when the water reached spillway level at a depth of 38 ft. Although the gates were opened early Monday (May 21), flood inflow almost equaled the discharge, so that the draw-down was only 2 in. per day.

"With reference to the stability of the structure, the designers and the railroad and state officials all agree that there was no evidence of movement of the rock-fill portion. The repair work will consist simply in rebuilding the dam to former dimensions. No change will be made in the design. During reconstruction careful watch will be kept not to fill the hole faster than the material in the upper portion can absorb moisture and swell to homogeneous mass.

"The cause of the leakage is generally considered to have been transverse shrinkage cracks through which the water passed before the material had time to swell. This year the water had been allowed to rise rapidly 8 ft. above last year's impounding. Last spring during filling C. J. Ullrich, in informal inspection, had noted two transverse 1-in. cracks about 5 ft. deep. He called the attention of the directors of the district to them with an injunction to puddle the cracks before the water rose to spillway level. Inspection again last fall by Mr. Ullrich showed no evidence of cracks. Springs encountered in driving the outlet tunnel had no bearing on the present trouble, as bottom seepage previous to this top leakage was zero, showing a remarkably tight dam in the lower portion."

License Sought for Dam on Flathead River

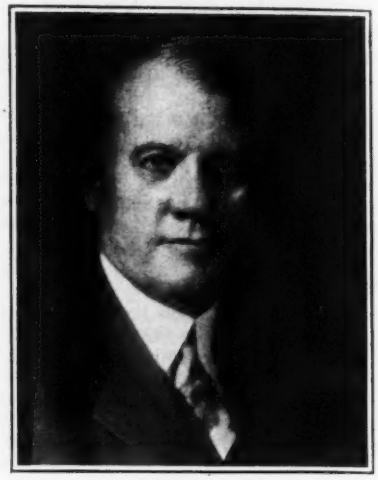
The Rocky Mountain Power Company, Butte, Mont., has applied to the Federal Power Commission for a license covering one of the five sites on the Flathead River included in its preliminary permit. As the first step in the development the company proposes to erect a 180-ft. dam, which will regulate Flathead Lake and permit it to act as a reservoir. It is planned to install 148,000 hp. at the first dam, where 80,000 hp. of primary power will be developed. The difficulty represented by the Newell tunnel has been removed through the passage of the Interior Department appropriation bill.

Timber Research Fellowship

Washington University, St. Louis, Mo., is offering two fellowships in timber research for the school year 1928-29 which have been established by the American Creosoting Company of Louisville, Ky. One of these is still open. These fellowships pay $1,000 and tuition yearly.

Appointment of Sturtevant to Mississippi Board Confirmed

With the confirmation of Carlton W. Sturtevant, the board of three which will pass upon the differences between the flood control plans of the army engineers and of the Mississippi River Commission is prepared to begin its work. While the exact plans that will be followed have not been agreed upon, it is expected that the board will make an early trip down the river for the purpose of holding public hearings. Opinions from competent local persons will be sought. Among the differences



C. W. Sturtevant

that are to be considered on the trip will be the height of the levees on the main river from Cape Girardeau to the Gulf and the procedure in the handling of the diversions. Opposite Cairo, the army engineers have recommended a setback floodway. The Mississippi River Commission proposes to handle the situation there with levees. In the Boeuf Basin the army engineers recommend a wider floodway than does the Mississippi River Commission. The former propose a diversion of 900,000 sec.-ft. in maximum flood, while the latter plans to take care of 600,000 sec.-ft. there. The commission recommends a masonry spillway at the head of the basin, while the army engineers would make use of a "fuse plug" type of levee at that point.

At Red River, a more complicated series of differences will have to be considered at the hearings. The army engineers have planned a floodway to carry 1,500,000 sec.-ft. through the Atchafalaya Basin. The Mississippi River Commission expects to pass 950,000 sec.-ft. by that route. Again the width of spillways is involved and other important questions enter.

Although the plans agree on the spillway at Bonnet Carre, the entire question of diversion for the protection of the city of New Orleans must be considered, as the Mississippi River Commission report deals with a spillway below New Orleans, as well as the one above the city.

Personal Notes

CLIFFORD A. BETTS, office engineer for the Moffat Tunnel Commission, has received appointment with the Bureau of Reclamation and assigned to the Owyhee dam project. Mr. Betts will remain at the headquarters office in Denver until early June, after which he will assume the duties of office engineer at Owyhee.

T. A. BEDFORD, formerly district engineer, district No. 1, California Division of Highways, with headquarters at Eureka, has resigned that position and is now in Cuba for the Kaiser Paving Company, of Oakland, Calif., in connection with that firm's Cuban highway construction contract. Mr. Bedford served with the highway commission for sixteen years.

R. E. BORROWMAN has been appointed city engineer of St. Cloud, Minn., a position he held prior to the war. From 1924 to 1927 Mr. Borrowman was assistant director of public works, St. Petersburg, Fla., and later, until May 1 last, was chief engineer and sales manager of the Lewistown Culvert Company, Fort Wayne, Ind.

Col. LYTLE BROWN, Corps of Engineers, has been nominated by President Coolidge for promotion to the rank of brigadier-general. Colonel Brown was in charge of the construction of the Wilson dam in Alabama in 1919 and 1920. During the World War he served as chief of the War Plans Division, General Staff, at Washington.

CHARLES A. NEWHALL, consulting chemist, of San Francisco, Calif., and Seattle, Wash., has severed his connection with the Clay Products Association.

ELBERT C. MACY has assumed the post of vice-president in charge of operation of the Public Service Production Company (New Jersey) vacated by the retirement of Nathaniel A. Carle. Mr. Macy, a graduate of Iowa State College, has had extensive engineering experience in many parts of this country, as well as abroad, in the construction of railroads, power houses, dams, transmission lines and bridges.

F. G. MORSE, for eight years engineer and purchasing agent of the Uintah Railway Company, with headquarters at Mack, Colo., resigned and left the latter part of April for Trinidad, British West Indies, where he will take over the office of engineer for the Trinidad Lake Asphalt Company and for the New York & Bermudas Company, both concerns subsidiaries of the General Asphalt Company.

DEWEY W. ROSCOE, assistant city engineer of Fort Collins, Colo., resigned on May 1 to accept a position with the city engineer of Cheyenne, Wyo. Mr. Roscoe was in direct charge of a $700,000 pipe line and water system at Fort Collins last year and will be assigned to the enlargement of Cheyenne's water system, the voters having approved the bond issue.

E. T. JONES has been made district engineer in charge of the new branch office in St. Louis, Mo., which has been opened by the engineering firm of Russell & Axon, of Springfield, Mo. This firm has prepared the plans and supervised the construction of many waterworks, street paving and bridge construction projects in the Middle West, West and South.

MORTIMER G. BARNES has resigned his position as chief engineer of the Illinois State Division of Waterways, on account of ill health, but has been retained as consulting engineer.

LORENZO D. CORNISH, assistant chief engineer of the Illinois State Division of Waterways since 1920, has been appointed chief engineer, to succeed Mortimer G. Barnes, resigned. Mr. Cornish has his offices in Chicago.

Engineering Societies

Calendar

Annual Meetings

AMERICAN ASSOCIATION OF ENGINEERS, Chicago; Annual Convention, El Paso, Tex., June 4, 5 and 6.

AMERICAN WATER WORKS ASSOCIATION, New York; Annual Convention, San Francisco, week of June 11.

SOCIETY FOR THE PROMOTION OF ENGINEERING EDUCATION; Annual Meeting, University of North Carolina, June 25.

AMERICAN INSTITUTE OF QUANTITY SURVEYORS, Chicago; Annual Convention, New York, June 25-27.

AMERICAN SOCIETY FOR TESTING MATERIALS, Philadelphia; Annual Meeting, Atlantic City, June 25-29.

AMERICAN SOCIETY OF CIVIL ENGINEERS; Annual Convention, Buffalo, N. Y., July 18-20.

THE NORTH CAROLINA SOCIETY OF ENGINEERS will hold its annual meeting at Wrightsville Beach on June 22 and 23.

THE NEW YORK SECTION, American Society of Civil Engineers, at its annual meeting held May 16, elected the following officers: President, Willard Chevalier; vice-president, Theodore R. Kendall; directors, Ole Singstad and Harry D. Winsor, and secretary, V. T. Boughton. Following the annual meeting, three papers upon the foundations for the new Hudson River bridge at New York were presented and discussed, one by O. H. Ammann, chief engineer of bridges, Port of New York Authority; one by Daniel E. Moran, consulting engineer on the foundation work, which was presented by Carlton S. Proctor, and one by Francis Donaldson, chief engineer, the Silas Mason Company, contractor for the west pier foundation work.

Obituary

CHARLES I. CORP, professor of hydraulic and sanitary engineering at the University of Wisconsin, died on April 28. Mr. Corp was born at Nickerson, Kan., in 1879. He was graduated in 1903 from Kansas University, where he remained as instructor and assistant professor until 1912, when he went to Madison, Wis., as assistant professor in hydraulic engineering at the University of Wisconsin and became professor in this department in 1920. During the World War he served as captain in the sanitary corps and was camp sanitary engineer at Camp Kearney, near San Diego, Calif. Mr. Corp was president of the Engineering Society of Wisconsin in 1921 and its secretary since 1926. He was a member of the American Society of Mechanical Engineers and the Society for the Promotion of Engineering Education.

CLEVE ALPHEUS PURINGTON, until recently a resident of Claremont, Calif., died on May 10 at the San Antonio Hospital, Upland, Calif. Mr. Purington was 46 years old and up to the close of the World War was a shipbuilder. During the war he had charge of the government shipbuilding work at Seattle, and the pressure of his war-time activity brought on a nervous breakdown, from which he never fully recovered. For several years he was a member of the firm of Munson, Ruoff, Roalfe & Purington, engineers and architects, Los Angeles, and since 1924 he was a member of the engineering firm of Taylor & Purington, engaged in real estate developments in the vicinity of Claremont.

JAMES C. NAGLE, consulting engineer, Dallas, Tex., died on April 5. Mr. Nagle was born at Richmond, Va., in 1865, and was graduated from the University of Texas in 1889. After some early railroad experience he became professor of civil engineering at the Texas Agricultural and Mechanical College and was made dean of the school of civil engineering in 1911. This position he resigned in 1913 to become a member of the Texas State Board of Water Engineers, but returned to the college in 1917. He was assistant chief engineer of the Houston East & West Texas Railway in 1889 and later engaged in irrigation work under the U. S. Department of Agriculture. Mr. Nagle was consulting engineer for the Garza dam of the Dallas water supply, and a paper on this work by him and T. C. Shuler appeared in *Engineering News-Record* of May 17. At the time of his death he was a member of the engineering firm of Nagle, Witt, Rollins & Gilchrist.

HARRY S. SMITH, of May & Smith, consulting engineers, died of peritonitis on May 27. He was consulting engineer for the village of Patchogue, Long Island, and a director of the New York State Engineers.

Construction Equipment and Materials

A Section Devoted to What the Manufacturer Is Doing for the Engineer and Contractor

Road Show for 1929 to Be Held in Cleveland

The 1929 convention and road show of the American Road Builders Association will be held in Cleveland, Ohio, during the week of Jan. 14. It is reported that the extensive additions to the Cleveland Public Auditorium have been completed and will afford facilities for the convention program and the road show to be held simultaneously in the auditorium. Application blanks and other information will be available within the next few weeks, according to Charles M. Upham, director, American Road Builders Association, National Press Building, Washington, D. C.

Industrial Advertisers to Meet

The National Industrial Advertisers' Association will hold its seventh annual conference in the Chase Hotel, St. Louis, June 11, 12 and 13. The theme of the conference will be, "Can industrial advertising lower the cost of industrial sales—and how?" The addresses, as well as the exhibit, will be built around this subject. Approximately 500 panels of exhibits will be shown and ten competitions will be staged, bearing on such special characteristics as the best industrial advertising campaign, best direct mail advertising campaign, best institutional advertising, best advertisement by a business paper, most effective exhibit of not less than three industrial advertising campaigns prepared by an agency, best use of color, best series of not less than twelve pieces of industrial advertising featuring news, best series of not less than twelve advertisements featuring performance, and the most effective use of arrangement and typography in industrial advertising.

H. von P. Thomas, Bussman Manufacturing Company, St. Louis, secretary-treasurer of the N.I.A.A., is directing the general arrangements for the conference.

Business Notes

Worthington Pump & Machinery Corporation, New York City, has recently moved its head office, sales and advertising department to the plant of the corporation located at 421 Worthington Ave., Harrison, N. J.

American Hoist & Derrick Company, St. Paul, Minn., announces that the partnership interest of W. O. Washburn in the company has been purchased by Frank J. Johnson, the senior partner and one of the founders of the business. The business will be continued under the same name as a corporation with the following officers: F. J. Johnson, president and treasurer; Howard S. Johnson, vice-president in charge of sales; Frederic Crosby, vice-president in charge of production.

Colloy Products Company, Chouteau Trust Building, St. Louis, Mo., announces that it has taken over the Colloy Production Company for the manufacture of a dry powder known as "Colloy" which is added to concrete to produce a colloidal effect and thus increase its workability in the forms (see *Engineering News-Record*, Aug. 19, 1926, page 318). The Builders Specialty Company and the Imperial Waterproofing Company, both of Chicago, are distributors for the Chicago district, and the Tyee Stucco Works, Winnipeg, Manitoba, has been appointed distributor for western Canada.

Mundy Sales Corporation, New York City, announces the appointment of a number of new distributors as follows: E. F. Craven Company, Greensboro, N. C.; Lone Star Road Machinery Company, Dallas, Tex.; R. P. Sweeny Company, Greenville, S. C., and Nixon-Hasselle Company, Chattanooga, Tenn.

Olsen Manufacturing Company, Kenosha, Wis., has recently been organized and has taken over the plant occupied by the Kenosha Fire Engine & Truck Company. The new concern will begin operations by specializing in general machine shop work, including repairing and rebuilding of all types of motor trucks and other contractors' equipment. Special equipment will also be built to order.

Truscon Steel Company, Youngstown, Ohio, has recently purchased the Hydraulic Pressed Steel Company, Cleveland, Ohio, which will be operated as the former company's pressed steel division.

Kalman Steel Company, Chicago, has opened an office in the Barr Building, Washington, D. C. This office will act as a sub-agency to the Baltimore district office and will be in charge of Howard M. Lloyd.

Ohio Power Shovel Company, Lima, Ohio, announces the opening of an office at 30 Church Street, New York, N. Y., with L. H. Morris in charge; a Philadelphia office at 1119 South 56th Street, with E. E. Fort in charge; and a Chicago office at 1250 Straus Building, with H. P. Steinbrenner in charge.

Howard J. Griffin, formerly sales manager, Spencer Construction Co., Baltimore, Md., and for a number of years with Allis-Chalmers Mfg. Co., in the East, has joined the sales organization of the Chain Belt Co., Milwaukee.

Graver Corporation, East Chicago, Ind., announces the opening of an office in Los Angeles, to be in charge of Frank M. Beeson, who has recently been in charge of the Los Angeles branch of the Luitweiler Pumping Engine Company.

New Developments

Large Cast-Steel Valves for St. Louis Water-Works

There are at present under construction in the plant of the Michigan Valve & Foundry Company, Detroit, Mich., several cast-steel valves of unusual size and design which are to be installed in the new Missouri River pumping station at St. Louis. There are two 42-in., one 60-in. and two 48-in. valves, all of the solid-wedge type operated by means of hydraulic cylinders.

The wedges are similar to those employed in other large valves having an angle of 7 deg. between faces. The guide slots are equal in length and of two-thirds the wedge diameter. Contact surfaces of the guide slots will be of bronze, as are the face rings, which are secured to the wedge by means of a threaded connection. Because of the long wedge guides, square bottom body construction is being used. At the lower part of each side of the body are connected 4-in. gate valves serving as cleanouts. A bypass valve is also provided on one side, being of the rising stem type, the stem serving as an indicator.

The operating cylinders are lined with centrifugally cast bronze tubes, the mixture employed consisting of 85 per cent copper, 5 per cent tin, 5 per cent zinc and 5 per cent lead. The piston rings consist of square hydraulic packing rings held in position by means of a clamping ring. Pressure will be supplied to these cylinders by means of two pumps. The cylinders are designed to withstand a pressure of 300 lb. per sq.in., but a relief valve set at 200 lb. will be provided on the upper end of the cylinder to prevent jamming of the wedge during closing. The cylinder diameters are such that 125 lb. per sq.in. should be sufficient to obtain valve closure. A tale rod extends through the cylinder head equipped with a locking device to enable the piston to be held at any of its upper positions without relying upon the pressure beneath it. An eye piece for emergency operation is provided at the upper end of this rod.

Rolled manganese bronze possessing a minimum tensile strength of 65,000 lb.

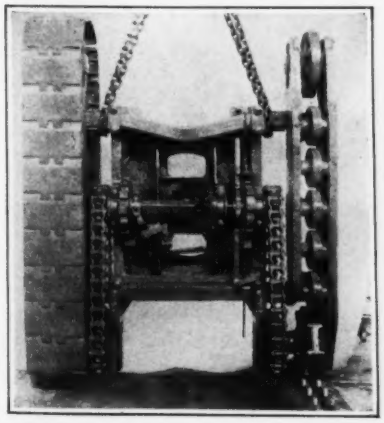
per sq.in. and an elongation of 20 per cent in 2 in. is employed for both the main stem and the tale rod. All bearing surfaces of the stem and rod are bronze to bronze. The steel castings for these valves are being supplied by the Erie Forge Company, Erie, Pa., and the centrifugally cast bronze liners by the Paper & Textile Machinery Company, Sandusky, Ohio. This information has been supplied by A. Ulbert, chief engineer, Michigan Valve & Foundry Company.

A Flexible Bolt

Flexible bolts, for use where rigid bolts are impractical, which have been developed by the American Cable Company, New York City, are made from the company's Tru-Lay rope and its Tru-Loc fittings. Such bolts can be used for hanging shafts, for suspending brackets carrying overhead steam or water piping, for supporting scaffolding and for similar uses. The fittings are applied by the patented process of the company—placed over the unseized end of the rope and cold flowed into the interstices of the rope by hydraulic pressure. The bolts are available in varying lengths.

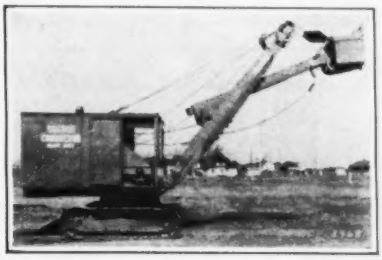
Changing Boom Converts New Gas-Shovel to Crane or Dragline

A full revolving heavy-duty gasoline shovel fully convertible to dragline, back-hoe, clamshell or crane has been announced by the Osgood Company, Marion, Ohio, as its Conqueror model.



The machine is mounted on a new crawler of the double-chain drive type. Changes in boom assemblies only are required for converting from one type to another since two drums are used; this may easily be done in the field.

Power is supplied by an 80-hp., 6-cylinder gasoline engine mounted at the rear of the massive unit-steel body casting. Heavy unit-steel side frames securely attached to the main body casting support the drum shaft and the reversing shaft. A special feature of this machine is the combination cast-iron gasoline tank and counterweight set into the deck at the rear of the engine. The wire-rope crowd, as used on previous Osgood machines, is continued in the new model. The crawler is built up entirely of steel castings with axles and cross-travel shaft of hammered steel. The truck



frame is a single steel casting. Five travel-rollers on each crawler operate on stationary shafts, lubricated by recessed high-pressure gun fittings.

A New Type Meter for Measuring Steam

A mechanical meter, similar in many respects to the domestic water meter, has been developed by the Builders Iron Foundry, Providence, R. I., for measuring steam. It is adaptable to all waterworks power plants operated by steam. It is known as the shunt steam meter and is placed directly in the pipe line. The total pounds of steam is read on a counter dial of the usual type. The meters are calibrated to read correctly for the particular pressure specified by the customer, and are made in 2 in., 3 in. and 4 in. types, suitable for steam pressures from 3 to 225-lb. gage.

In operation, a portion of the steam is deflected upward through nozzles and rotates a small turbine mounted on the vertical shaft. This arrangement eliminates moving parts from the main line of flow. Near the lower end of this shaft is mounted the damping fan which revolves in a chamber filled with water formed by condensation, keeping the turbine speed low. In this way the wear on all bearings is reduced and the range of the meter is increased. The counter train is driven by the turbine shaft through a permanent magnet. The vertical dial can be arranged to face in any desired direction to conform to the position of the meter in the pipe line.

Special Drawbar Used on New Crawler-Type Trailer

A new trailer known as Model CR-21 has recently been developed by the Miami Trailer-Scraper Company, Troy, Ohio, in which two-thirds of the load is carried on a rear crawler unit, the other third being carried on front steel wheels. The trailer is so designed that the fifth wheel can rock on top of the axle. Since the drawbar is hinged directly to the front axle, this construction allows the trailer to be used with any make of tractor for any difference in height between the tractor and the trailer. The fifth wheel design is also advantageous when passing over uneven ground since stresses are taken by the drawbar and not by the frame of the trailer. The trailer can be equipped with either a platform body or with bolsters. The platform body as furnished measures 6x12 ft. On the logging trailer bolsters are used, spaced 9 ft. center to center. The bolsters are each equipped with heavy chock blocks which are held in positions by chains but can be easily removed when necessary.

New Publications

Water Softening—THE ALUMINATE SALES CORPORATION, Chicago describes in a 12-page booklet its type F dry feeder for treating railroad water with sodium aluminate. Photographs are given of a number of installations.

Concrete Pipe—WESTERN CONCRETE PIPE COMPANY, Los Angeles, Calif., has published a 48-page catalog describing its method of manufacturing concrete pipe by the Hume centrifugal method. Many illustrations are given of the manufacturing processes as well as of pipe installations. Hydraulic data in the form of tables and charts are included in the catalog.

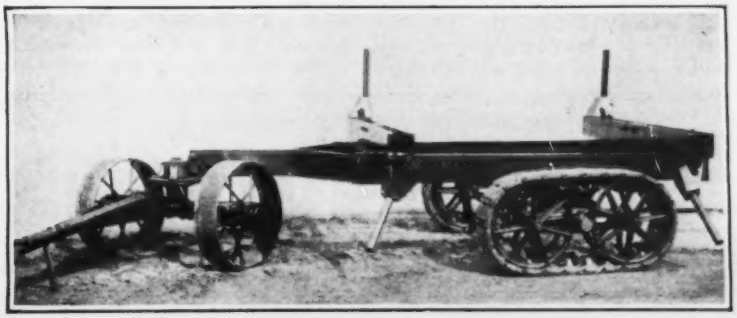
Manufacturers and Trade Associations

Calendar

Annual Meetings

AMERICAN WATERWORKS MANUFACTURERS ASSOCIATION, New York City; annual meeting, San Francisco, Calif., June 11-14.

TRACK SUPPLY ASSOCIATION, Chicago; annual exhibition and convention, Detroit, Sept. 18-20, 1928.



Business Side of Construction

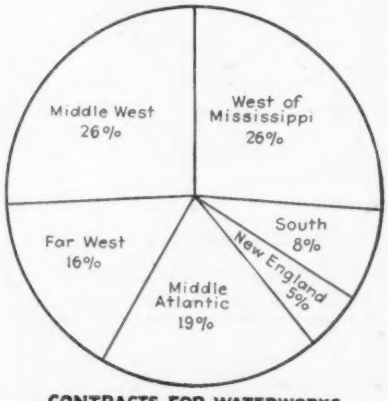
Facts and Events That Affect Cost and Volume

Water-Works Awards Show Highest Value Since October, 1925

WATER-WORKS contracts awarded during the first four weeks of May, 1928, totaled $13,133,000, exceeding the total for every month since October, 1925, when contracts let during five weeks totaled $17,600,000. The total awards in 1928 to date, including only four weeks of May, were 2 per cent lower than those let in the first five months of 1927, and 7 per cent lower than those let in the corresponding period of 1925. Two contracts awarded in May, 1928, for Boston water-works, totaled $8,874,344.

There were 152 contracts for water-works awarded in the first four months of 1928, and the yearly totals in 1926 and 1927 were 660 and 621, respectively. The average contract value was $117,500 in 1928, $85,600 in 1927 and $93,300 in 1926.

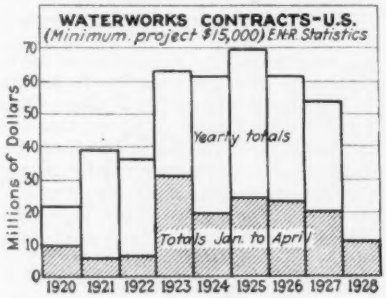
Water-works contracts constituted 1.73 per cent of all construction awards in 1928, 1.64 per cent in 1927 and 2.16 per cent of the 1926 total. In 1923 this class made up 3.3 per cent of total contract values—the highest proportion in the last ten years.



CONTRACTS FOR WATERWORKS SECTIONAL DISTRIBUTION
(Based on total awards in last five years)
E.N.-R. Statistics

Geographical distribution of water-works awards during the five-year period 1923-27 showed the greatest volume of this class of construction to have taken place in the Middle West and west of the Mississippi. The chart shows the relative volume of contracts in each section of the country.

There were 306 projects in the proposed state (not ready for bids) reported in the first four months of 1928.



The total value of 1928 proposed work was $128,520,000. Sectional distribution of proposed water-works projects in the last three years was as follows:

	(000 Omitted) 1928 4 Months	1927 12 Months	1926 12 Months
New England	$5,518	$3,973	$24,487
Middle Atlantic	1,958	13,217	11,182
South	2,737	9,420	15,894
Middle West	9,342	45,740	23,932
West of Mississippi	11,938	21,958	37,848
Far West	97,027	54,008	26,281
Total U. S.	$128,520	$148,316	$139,624

Schwab Asks Study of Waste in Distributing Steel

The waste in cross-hauling steel products was emphasized by Charles M. Schwab at the 33d meeting of the American Iron and Steel Institute in New York on May 25. Mr. Schwab pointed to the low return on the five billions invested in the steel industry and proposed elimination of distribution waste as an alternative to further reduction of production costs or price raising. He recommended the appointment of a committee "to study this problem with a view frankly to recommend to the public and to the proper public authorities a constructive plan which may result in such modification of existing law as will enable the factors in the steel industry, and indeed possibly in other industries, to achieve those economies which are so important."

E. N.-R. Index Numbers

Cost			Volume		
May 1,	**1928**	**207.00**	**April,**	**1928**	**316**
Apr. 1,	1928	206.40	March,	1928	318
May 1,	1927	206.80	April,	1927	257
Average,	1927	206.24	Average,	1927	263
Average,	1926	208.03	Average,	1926	228
1913		100.00	1913		100

Business Notes

New capital issues floated in the New York market in the first four months of 1928 total $3,226,467,000, compared with $2,574,031,030 in the corresponding period of 1927. The figures for London are $609,840,000 in 1928 and $526,065,000 in 1927. April financing in the United States was a record high.

Tin plate contracts for the second half of the year are being received by the Youngstown plants, which are working at 90 per cent capacity.

In the iron and steel industry, bars are in chief demand, due to the diversity of the outlet. Chicago bar mills have a larger volume of orders and are shipping more steel than a year ago. Volume is lacking in the demand for plates and for railroad materials and equipment. Sheet mill operations vary from 50 per cent in Chicago to 84 per cent in the Mahoning Valley, with Pittsburgh at 80 per cent. Reinforcing bar business of the week totaled 9,295 tons, compared with 5,150 for the previous week and 8,511 a year ago, according to the *Iron Trade Review*. The week's awards for structural shapes totaled 34,215 tons, compared with 31,544 for the previous week, the average for 1928 being 39,401.

The *Electrical World* index of consumption of electrical energy by the manufacturing industries is 128.4 for April, compared with 115.3 for March and 108.9 for April, 1927. Operations in the electrical industry have been consistently higher this year than last, which is a normal condition; but indications in April and May point to an acceleration in the normal increase.

The call loan renewal rate for the three weeks ended May 19 was 5.5 per cent. The average daily rate in April was 5.08 and in May, 1927, the rate was 4.26 per cent. Commercial paper has been 4½ per cent during May and had a range of 4¼-4½ in April and 4-4¼ in May, 1927. The discount rate of the New York Federal Reserve Bank was raised from 4 to 4½ in the third week of May.

This Week's Contracts

Heavy construction contracts, reported by *Engineering News-Record* in the week ended May 31, with some comparisons, total as follows:

(In Thousands of Dollars, 000 Omitted)

Week Ended	Public	Private	Total
May 31, 1928	**$28,413**	**$35,205**	**$63,618**
May 24, 1928	29,076	32,247	61,323
June 2, 1927	58,464	27,629	86,093
Jan. 1 to date:			
1928	539,114	911,468	1,450,582
1927	492,790	755,854	1,248,644

WATER-WORKS CONTRACTS BY SECTIONS
(000 Omitted)

	New England	Middle Atlantic	South	Mid-West	West of Mississippi	Far West	Total
1923	$947	$21,420	$3,208	$17,626	$12,668	$6,829	$62,698
1924	4,284	8,485	6,783	13,047	20,124	8,722	61,445
1925	2,203	11,845	3,305	14,710	20,018	17,287	69,368
1926	5,098	8,730	5,605	18,662	15,395	8,157	61,647
1927	3,650	8,283	5,201	14,336	12,818	8,901	53,189
1928	9,133	3,468	1,529	3,597	3,601	2,719	24,047